PARAFFIN IN SURGERY

A CRITICAL AND CLINICAL STUDY

—BY—

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WITH THIRTY-EIGHT ILLUSTRATIONS

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To Dr. ARPAD G. GERSTER

OUR HONORED FRIEND
AND TEACHER

IN APPRECIATION OF HIS INTEREST IN OUR WORK.

PREFACE

Since the introduction of paraffin into the domain of surgery, much has been written of its indications and contraindications, its accidental effects and dangers; much controversial testimony has been published concerning the general methods and the technics of its employment; and, especially, have there appeared confused notions of the dispositions of paraffin in the tissues—notions based on faulty observations.

In this monograph it has been our effort to collate and analyze this voluminous literature and, by the critical study of the results of our clinical experiences and our experiments upon cadavers and animals, to determine some of the disputed points, the practical importance of which we have also explained.

Some of the photographic negatives of patients after paraffin injections, set aside for development at our leisure, were unfortunately spoiled by accidental exposure to X-rays. Where we were unable to secure duplicate negatives, we were therefore obliged to "doctor" pictures of the patients taken before injection, in order to show the result. In this "doctoring," however, we were careful to follow exactly the lines of the fogged plates.

We desire to thank Dr. Henry Rogers, Pathologist to the Harlem Hospital, and Dr. Carl Goldmark, Clinical Microscopist to the Mount Sinai Hospital Dispensary, for the preparation of the microscopical sections, and Mr. William Leaming, of the New York College of Physicians and Surgeons, for the photomicrographs. Especially do we wish to record our indebtedness to our colleague, Dr. Walter M. Brickner, for supplying us with clinical material and assisting in many of our operations, and for his valuable aid and advice in the preparation of our manuscript.

W. H. L.
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PART I

CHAPTER I

Introductory.—The Sphere of Parraffin Injections. Arguments Concerning the Disposition of Paraffin in the Tissues.

History

When five years ago Gersuny published his article "Subcutane Prosthese,"[1] the Paraffin idea was greeted as a revelation. His own cases, as well as the broad field of indications and possible usefulness mentioned and suggested by him, opened up a large prospective for the procedure and the subject was taken up by the profession with startling rapidity.

The basis of Gersuny's experiments was as follows: If melted vaselin is injected into the soft tissues of the human body, the embedded mass, after hardening, apparently remains unchanged and stays where it has been deposited. He came to that conclusion years before, when engaged in certain therapeutic experiments, without paying much attention to the fact at the time.

If the agent employed by him was a new one, the idea itself certainly was not; for as far back as 1891 our own Corning[2] suggested the introduction (and subsequent refrigeration) of solidifying oil into the subcutaneous tissue in order to bring about the occlusion of blood-vessels. Like so many suggestions, however, that have

gone astray only to be brought to life again after awhile by some other observer, Corning's method passed silently away and it is now by Gersuny's recent efforts that universal attention has been called to the merits of Corning's experiments.

Indications

The indications suggested originally by Gersuny are manifold. Upon close scrutiny, however, one is able to divide them into two classes: first, functional; and second, cosmetic improvements. The first embraces intervention in cases of paralysis of the soft palate, of insufficiency of the anal and vesical sphincters, of hernia, of prolapsus uteri; for the prevention of ankylosis after resection, the support of an artificial anus, of varicose veins, etc. The second class includes injections after removal of testicles or mammæ, for depressed, disfiguring cicatrices, to fill up bone scars such as occur after operation for osteomyelitis, etc., perhaps also for filling brain defects, and finally injections in cases of saddle-nose deformity, from fracture or loss of septum by disease.

Immediate and Ultimate Disposition of the Paraffin in the Tissues

The first question that naturally arises is, *What becomes of the paraffin after it is embedded in live tissue?*

There is one point on which all authors agree—which is that soon after the injection of the paraffin a traumatic inflammatory reaction takes place, produced by the heat of the paraffin and the tearing, stretching or forcing apart of the various tissue fibers, leading eventually to the formation of connective tissue, resulting, as in the case of any foreign body, in an attempted encapsulation of the injected material, assuming, of course, that we are dealing with a sterile agent.

From this point on the opinions vary so greatly that controversy arose—the development of which we shall briefly outline.

The first bone of contention was presented by Pfannenstiel[3], who injected paraffin in a case of incontinence of urine, the amount deposited being 30 c. c. Embolus of the lungs resulted; but eventually the patient recovered, the operation, as such, remaining a failure. Then Meyer[4] came out with the statement that according to his researches (experiments on rats) it is probable that paraffin is slowly absorbed; hence the possible danger of an obstruction of the lymphatics if the paraffin is injected in large quantities.* Endorsement of this theory came from Jukuff[5], who says, in part: "The small paraffin globuli, broken off from the injected mass by muscular contraction, travel and stimulate connective tissue and cell proliferation of the adjoining tissues in their way. They thus get grown through like a sponge and are formed into a meshwork. Progressively smaller and smaller particles of the proliferating connective tissue are thus isolated, and finally, after a long time, the foreign body is transformed into a sort of emulsion ready to be absorbed by the lymphatics."

Gersuny's[6] views are entirely different—he objects strenuously to the idea of the traveling paraffin globuli. He says: "A few hours after injection the conditions are entirely changed. A small cell infiltration sets in; soon the vaselin, like any foreign body, is encapsulated, and the traveling of paraffin globuli cannot occur unless that capsule is ruptured. Microscopically, the specimen taken from an injected area resembles an inflamed lipoma:

*Meyer injected paraffin into rats. The animals were then digested in a concentrated alcoholic solution of potassium hydroxid at 70 degrees to 80 degrees C., and the paraffin extracted in an exceedingly complicated manner. In one case he recovered 79.29 per cent. of the original amount after 38 days; in another, 42.08 per cent. after 58 days.

i. e., shows strongly refracting lumps of varying size embedded in small cell infiltrated stroma."

In the meantime Moskiewitz[7], Gersuny's assistant, was detailed to study the question thoroughly, and a little later he came to the following conclusion: "Like every foreign body, paraffin stimulates the growth of connective tissue cells. The granulation areas thus produced invade the paraffin as they would an implanted sponge; progressively smaller vaselin particles are thus broken off from the original deposit; the pillars of the meshwork consisting of granulation cells are slowly converted into connective tissue. Specimens taken from the ear of a rabbit three months after an injection, show a firmly coherent, central vaselin mass, well encapsulated in connective tissue." He further says that if the injected vaselin is left undisturbed for a time and protected from muscular contractions or pressure from outside, it becomes firmly encapsulated and should be well able to withstand absorption.

An entirely new light was thrown upon the question by Eckstein[8]. Thus far, only vaselin or paraffin of a melting-point from 92° to 100° F. had been spoken of. Eckstein thought that the reported accidents were attributable to the softness of the material, and therefore he proposed to use paraffin with a melting point far above the normal bodily temperature—*i. e.*, at 130° to 135° F. He implanted chunks of hard paraffin of various melting points into the back and underneath the forehead of rabbits to find out particulars about the absorption of the paraffin. And from the fact that the pieces of high melting point after three months did not lose, appreciably, any of their defined weight, while those of a lower melting point showed losses, he tried to draw conclusions as to the final disposition of the hard and soft paraffin, respectively. In all cases he found the paraffin enclosed in a capsule of connective tissue, the formation

of which begins in the first few days. The capsule, if a few weeks or months old, is easily peeled off as a whole and shows on its inner surface a uniform, shining surface, nowhere accrescent to the paraffin. Microscopically, the capsule consists almost exclusively of connective tissue fibers poor in nuclei. The central parts of the capsule adjacent to the paraffin show hardly any bloodvessels, thus completing the resemblance to the histological picture of a scar. These findings lead him to the conclusion that, different from, the vaselin or paraffin of very low melting point—which, according to Gersuny, is permeated by the proliferant connective tissue and subdivided in meshes of connective tissue in the shape of single, shining globuli of small proportions, perhaps apt to be absorbed—paraffin of high melting point will never yield to absorption.

Leiser[9] records about the same time another accident. He injected paraffin in a case of saddle-nose, and amaurosis followed through thrombosis of the ophthalmic vein; while Luxenburger[10] reports two cases of facial hemiatrophy in which injections of paraffin gave good cosmetic results without the least disturbance being noted.

The split between the authors is now complete and the arguments manifold, according as to whether hard or soft paraffin is used. Gersuny, Moskiewitz, Wasserman[11], Karewsky[12] and others are using vaselin or soft paraffin of a melting point up to about 100° F.

Karewsky reports excellent results after using paraffin in cases of prolapsus ani in children. He achieved perfect success in seven cases out of a total of eight. Wasserman reports five cases of saddle-nose deformity. In one, a case of congenital deformity, the skin was so adherent that although only 2½ c. c. had been used, sloughing resulted and was followed by gangrene and entire loss of the soft tissues. An ultimate skin-grafting

resulted satisfactorily. His other cases gave perfect results. He used pure soft vaselin.

Korman[13] also had good results with paraffin melting at about 100° F. In one of his saddle-nose cases the patient contracted, six months later, an erysipelas of the face which passed by without in any way disturbing the shape of the nose.

Eckstein and his followers, notably French and Belgian authors cling to hard paraffin. The field of indications is also notably widening. Alt[13] took up the injections for filling up grooves remaining after mastoid operations; and also to repair contorted or softened ears following perichondritis. Frey[14] had good results in similar cases. Broeckart[15] sees a good field in paraffin injections in various diseases of the upper respiratory passages. Cases of atrophy of the nasal mucous membrane should be amenable to treatment. Some authors, as Brindel[16], Delie[17], and Lake[18] report good results in that direction. They inject the paraffin underneath the mucous membrane of the lower and middle turbinates and claim that the narrowing of the two large nasal cavities does away with the formation of dry scales, scabs, etc., and the exsiccation of the pharynx. It is even alleged that after the injection of the paraffin (into the nasal submucous tissue) the bad odor of ozena rapidly disappears. Burmeister[19] implanted a solid paraffin chunk of about 125° F. melting point in the place of an excised tuberculous testicle, and obtained healing without the slightest reaction.

The year 1903 is particularly rich in publications on this subject. The question is now in its fourth year, and experiences are reported from all sections of the world. The controversy proper, however, has narrowed down and now lies practically between Vienna and Berlin.

Gersuny and his followers, notably Moskiewitz and Stein, see no reason for abandoning the soft paraffin, while Eckstein and his pupils advocate with equal fervor the use of the hard variety, or paraffin with a high melting-point. Both sides exert the most feverish activity, and it is undoubtedly due to this rivalry that so many authors have contributed to the clearing up of the matter.

Moskiewitz[20] has found, after three years' experiments, that the histological picture of the excised specimens depends to a certain extent on the clinical symptoms after the injection. If the incorporation of the paraffin was not followed by a local reddening and swelling, the sections show a lesser degree of reaction. In these cases he finds a central, larger, irregular space stuffed with paraffin, surrounded by numerous small, round, more or less sharply defined spaces, in size diminishing toward the periphery. The small cell infiltration is slight; giant cells are not present. The vaselin presents itself in the shape of finest needles. In spots of larger dimensions the crystals are conglomerate in nidi of oval shape, which are interlocked by a nest of finest detritus; a few polynuclear leucocytes are visible, irregularly scattered. So the vaselin does not form one compact mass, but is crumbled up. The interspaces are filled out with serum. From the walls of the larger spaces small pillars penetrate into the vaselin—*probably rents of the connective tissue torn off at the time of the injection.* The occurrence of new growth of, and growing through of, connective tissue is a question which Moskiewitz refrains from answering at this time. *Entirely different* is the picture if the paraffin was injected into *scar tissue;* signs of strong reaction prevail. The small cell infiltration is more marked, the proliferation of connective tissue cells in the vicinity of the paraffin is very pronounced. Giant cells show in great number, which is

always the histologic manifestation of strong reaction. He had two accidents in the meantime. In two cases of descensus uteri 30 c. c. to 60 c. c. of vaselin were injected beneath the vaginal mucous membrane and in the parametria. Emboli of the lungs followed in both instances, though the cases ultimately recovered. He also reports two very interesting cases of fungous gonitis in which, after excision of the capsule, paraffin was deposited to prevent ankylosis. In the first case 100 c. c. were poured between the ends of the bones. The paraffin healed in without reaction and the knee was afterwards perfectly useful.

Another favorable case to show the disposition of the paraffin was published by Wenzel[21]. He made an attempt to occlude a laparocele by injection of paraffin, which failed. One year later a radical operation was performed, with excision of a portion of the hernial sac, which contained paraffin deposits from his previous intervention. Each deposit was firmly surrounded by a connective tissue capsule. No trace of permeating tissue fibers was visible. He concluded that the organization theory is unfounded. Wendel[22] is of the same opinion.

A very valuable article by Hertel[23] adds more light to the solution of the problem. His researches were directed to finding out the stability of the various preparations used. He was studying the question of replacing, by paraffin, the defect in the orbit after removal of the eye, and this led him to institute three different series of experiments. In series No. 1, injections were made with unguentum paraffin melting at about 100° F. (It may be mentioned, incidentally, that he lost two animals of this series through emboli of the lungs.) In series No. 2, chunks of hard paraffin melting at about 155° F. were implanted. In some cases where inflammation set in the paraffin was evacuated. Series No. 3 consisted of in-

jections of paraffin with a melting point ranging from 130° F. to 155° F. The specimens were removed twelve to fifteen months after implantation, and microscopically he found: Series No. 1—distinct marks of inflammation around the paraffin, conglomeration of round cells associated with proliferation of the connective tissue cells, and connective tissue fibers permeating into the paraffin, which thus was divided into numerous small net holes of varying shape. Series No. 3—Capsule around the paraffin consisting essentially of new connective tissue fibers. Some proliferation and fine tissue fibers permeating the mass. The inner surface of the capsule revealing in spots small elevations, zones rich in nuclei, where arise tiny filaments penetrating sometimes far into the paraffin mass. Series No. 2—practically the same as No. 3, though much less in evidence.

Hertel's deductions are so interesting that we deem it necessary to dwell upon them in a detailed manner. He thinks that these differing results lie with the differing distribution of the paraffin with regard to the tissue. He refers to Leber's experiments, proving that the irritative effects of foreign bodies upon the tissues are augmented if they are more finely divided. The larger the surface they come in contact with the more intense the irritative effects. So we note the most powerful irritative effect in Series No. 1, where the distribution of the paraffin is most irregular and widespreading; while in Series No. 2, where solid chunks with smooth surfaces were used, the reaction is mildest. An additional point may be found in the initial irritation, which certainly must have been greater in Series 1 and 3, because of the temperature of the injected paraffin solution. Still another factor to be reckoned with is the different chemical compositions of the paraffin used in the three series. Paraffin is no homogenous body. It is a product of distilled

brown coal-tar. The richer in coal elements the higher the melting point. It is obvious that this manifest chemical variation in the paraffin used plays its part in the degree of the irritation produced. A final point to be considered is that the solubility of the paraffin has also some influence upon the amount of irritation, which must be greater with paraffins of higher melting points than with those poorer in coal elements. It is a known fact that the middle members of the paraffin group are rather easily soluble in alcohol and ether, while the paraffins of high melting point are hardly soluble. Hertel concludes that there is a new growth of connective tissue going on, which ultimately leads to the resorption of the paraffin. The harder the paraffin the more protracted the absorption process.

Eckstein[25], while paying due respect to the thorough investigations of Hertel, does not share the conclusions drawn therefrom. The description of Hertel's specimens suggests to him quite a different point of view. If hard paraffin is injected while in a liquid state, it is well able to encircle and imbed solitary pre-existing connective tissue fibers. If such a specimen is examined later, it naturally produces the impression that the connective tissue fibers had ultimately grown into the paraffin. This seems to be confirmed by the fact that Hertel found these fibers scarcely dispersed in those cases where hard chunks of paraffin (Series No. 2) had been implanted. The explanation of their presence at all, Eckstein says, may rest with the impossibility of cutting and adapting paraffin chunks without inflicting slight bruises and crevices on their surfaces, which depressions afford spaces into which the connective tissue fibers, produced by the irritation around the paraffin, tend to enter and fill. As to his own observations, Eckstein asserts that vaselin, as used by Gersuny and his assistants, is not sta-

ble. He describes the case of a physician whose saddle-nose was injected with paraffin of 105° F. The paraffin, one year after injection, slipped and settled in knots on both sides of the nose. The patient tried to massage them away and was so successful that one year later, when he presented himself, no trace of the injected mass existed—which points to either absorption or traveling, or to both.

Stein[26], after careful investigations of specimens injected two years previously, comes to the conclusion that connective tissue grows through soft paraffin but the paraffin is not absorbed. It gains in due time the consistency of normal body tissue. Hard paraffin, however, is encapsulated. No growing-through occurs, but it stays within the capsule undisturbed.

Our own literature is rather poor on the subject of the disposition of the paraffin. Most of the articles concerning paraffin injections deal only with the technic of the operation, reports of cases, etc. Innumerable cases have been reported before societies, etc., that have never been published. Passing over the articles of Scanes Spicer[27], Harmon Smith[28], Lynch[29], Heath[30]—pioneers in the American literature—Grimmer[31], Eising[32], Hal Foster[33], Eastman[34], Parker[35], Proteus[36], Sucker[37], Allen[38], Murphy[39], Alter[40], Quinlan[41], Connell[42] and Clevenger[43], which are more or less reports of cases, or relate to slight modifications of technic, without in any manner throwing light upon the question of the disposition of the paraffin, we come next to Comstock[44], who is practically the first author in this country to attempt experimentally to show the disposition of the paraffin.

His experiments were instituted primarily to show the best melting point at which paraffin could be injected.

He used a mixture of commercial paraffin having a melting point at 120° F. and white cosmolin melting at 100° F., so combining these as to have samples melting at 102° F., 104° F., and 110° F., respectively. In all cases in which the paraffin was used at 102° F., the animals, rabbits, died within two weeks from thrombosis.*

His photomicrographs, twelve in number, are very beautiful, showing great care and perfect technic in preparation. He concludes that paraffin must at all times be above the body temperature in order to prevent any danger from the formation of emboli. The toxic dose would be from ten to fifteen pounds to the average person, and the proper melting point for injection into the human body is 106° or 107° F. The difference in the congestion and inflammation set up by the paraffins of different melting point was scarcely perceptible.

He says that the paraffin is grown through and into by connective tissues which throws out numerous spindle-shaped processes, showing the development of new connective tissue, etc., which is conclusive evidence of the beginning organization of the mass. He speaks of "new tissue" that perforates the embedded paraffin, "forming a new, firm and well-organized mass." He says in particular: "In all cases I have noticed a certain amount of apparent shrinking as the mass hardened and organized, which is probably due to absorption of the small amount of oil which is in the paraffin, leaving only the solid residue. This change leaves minute, softened openings, through which the little tissue cells make their first entrance in their attempt to bring into the fold this stranger from the material world." He further expresses his pleasure in being able to present his evidence

*It will be remembered that the normal temperature of rabbits is 102.5 degrees F., hence this sample had a melting point slightly below the body temperature.

to prove the fact that "we have a substance which will fill in the spaces of lost tissue and not remain entirely a capsulated body, but become a bridgework, and, in fact, a part of the new tissue."

More recently Morton[45], who used sperm oil to reduce the melting point of hard paraffin, in describing comparative sections of which he shows photomicrographs, says of one: "The connective tissue has increased and new bloodvessels are permeating it. The masses of paraffin grow smaller and smaller, and are surrounded by embryonic tissue which has penetrated the paraffin." Of another section he says: "It shows a vast increase of new tissue, connective, fibrous, and embryonic, with a decrease in the amount of paraffin." He states that these sections show conclusively that the paraffin soon disappears; whether it undergoes some chemical change, or whether it is conveyed away through the lymphatic system by the leucocytes, remains to be settled. Special attention is called to the fact that by the end of four months the injected paraffin is more or less completely removed and its place is occupied by organized tissue.

With this we have reviewed practically all the interesting articles published to date, excepting a few by English writers, such as Downie[46], Paget[47], Ramsey[48], Douglass and Stone[49]; and Cocchi[50] in Cuba, and Lagarde[51] in France.

The discussion we have recorded brings us no nearer a solution of the very interesting and all-absorbing question. Honors are almost even; the one-half saying that paraffin is absorbed, the other saying that paraffin is not absorbed. They all seem to agree, however, that the paraffin is grown into by new connective tissue fibers, which results in the organization of new tissue. Can

this apparent great difference of opinion be reconciled? Is there an explanation for this great divergence of opinion, regarding the disposition of the paraffin, of the many well-known writers, possessing equal merit and credibility, who have given us the benefit of their careful, painstaking experimentation and labors? We answer in the affirmative.

We believe that it was possible for authors of such high distinction to arrive at conclusions so absolutely contrary—simply because they reasoned from altogether false premises. False premises as to (1) *The chemistry of the paraffin,* which was entirely ignored by most writers. (2) *The early—that is, the immediate—disposition of the paraffin in the tissues.* (3) *The physical state of the paraffin at the time of the injection.* The overlooking of these three most important basic principles has caused a misinterpretation of some otherwise carefully executed experiments and tedious labors, resulting in partly or altogether erroneous conclusions being drawn therefrom.

CHAPTER II

Chemistry of Paraffin

It is not to be denied that he who, without possessing the knowledge of an expert chemist, attempts to study the chemistry of paraffin, finds himself confronted with a rather puzzling and perplexing aggregate of vague terms, and is soon lost in a maze of technicalities. His mind is apt to become befuddled by the endless and rapid transition from the lower members of the series, gases, through the fluids to the higher solids, and to the ethers, esters, olefins, ketones, aldehydes, etc. There is something undefined and unsatisfactory about the whole subject, and the more one reads the less clearly he sees his way through the labyrinth of possibilities.

Paraffin was discovered in 1830 by Reichenbach[52], who gave it the name, derived from *parum,* too little and *affinis,* affined or akin; because it was not attacked in the cold by such energetic oxidizing agents as concentrated sulphuric and nitric acids. It is the denomination of a series of saturated or limit hydrocarbons, so-called on account of the fact that they cannot unite with any more atoms or groups of atoms. They are obtained in large quantities in the dry distillation of peat, turf, brown coal, bituminous shale, and cannel coal, rich in hydrogen. From the tar which is produced at the same time a mixture of paraffins is obtained by fractional distillation. Wood and coal-tar contain, on the contrary, chiefly aromatic hydrocarbons. They occur already formed in petroleum, particularly that in America, which consists al-

most exclusively of them, and contains all of them, from methane to the highest.

It is difficult to isolate the individuals from such mixtures. Caucasian petroleum contains chiefly the aromatic hydrocarbons and the hydrogen addition products of the same. The German petroleums stand between these two kinds. They occur comparatively pure in the mineral kingdom as mineral wax—ozocerite.

The general or algebraic formula of the series is

$$C_n H_{2n} + 2.$$

The lowest member of the group is methane, or marsh gas, CH_4. A long line of varieties runs from this up to the hardest paraffin, called dimyricyl, $C_{60} H_{122}$, melting point 102° C. (215.6° F.)

The lowest members of the series up to butane and tetramethylmethane are gases at the ordinary temperature. The middle members are colorless liquids with a faint but characteristic odor. The higher representatives beginning with hexadecane, $C_{16}H_{34}$, are crystalline solids.

The chemical constitution of the paraffins is unknown. They contain, in percentages:

C 50-55
H 6.6-7.3
N 15-19
O 19-24
S 0.3-2.4

Though generally related, and possessing many features in common, the different members of the paraffin series are distinguished by characteristic physical and chemical properties, which serve not only for their identification, but for their classification into more or less well defined groups. All the physical properties of the constituents of this long series vary in accord with the rise of the molecular weight.

They are almost, or altogether, insoluble in water and cold alcohol. They are soluble in boiling alcohol and in ether, fatty and volatile oils, and mineral oils. The solubility of the higher members decreases as the amount of carbon increases. Their melting points increase with the addition of the carbon. That is, the boiling point, minus at the bottom of the series, steadily ascends as we go higher[53] in the series. The density shows the same graduation. From gaseous it becomes fluid, then viscid, and finally solid.

While paraffins are not attacked in the cold by such energetic oxidizing agents as concentrated sulphuric acid or nitric acid, chlorin has a substitution action, bromin a less energetic, and iodin is substituted in the presence of an oxidizing agent.

The commercial products known as vaselin, petrolatum U. S. P., cosmolin, etc., are not pure paraffins, but are mixtures of several paraffins and the heavier petroleum oils; their consistency depends upon the relative proportions of the higher paraffins of increasing melting point which they contain, from the oily petrolatum liquidum, U. S. P., to the hard petrolatum durum, U. S. P.

The name, formula and melting point of these harder or higher paraffins are as follows:

		Melting	*Point:*
Hexadecane,	$C_{16}H_{34}$	18°.0 C.	64°.4 F.
Heptadecane,	$C_{17}H_{36}$	22°.5 C.	72°.5 F.
Octadecane,	$C_{18}H_{38}$	28°.0 C.	82°.40 F.
Nonadecane,	$C_{19}H_{40}$	32°.0 C.	89°.60 F.
Eicosane,	$C_{20}H_{42}$	36°.0 C.	96°.80 F.
Heneicosane,	$C_{21}H_{44}$	40°.4 C.	104°.72 F.
Docosane,	$C_{22}H_{46}$	44°.4 C.	111°.92 F.
Tricosane,	$C_{23}H_{48}$	47°.7 C.	117°.86 F.
Tetracosane,	$C_{24}H_{50}$	51°.1 C.	123°.98 F.

Here occurs the first break, and we jump to:

Heptacosane,	$C_{27}H_{56}$	59°.5 C.	139°.10 F.
Hentriacotane,	$C_{31}H_{64}$	68°.1 C.	154°.58 F.
Datriacotane,	$C_{32}H_{66}$	70°.0 C.	158°.00 F.
Petatriacotane,	$C_{35}H_{72}$	74°.7 C.	166°.46 F.
Dimyricyl,	$C_{60}H_{122}$	102°.0 C.	215°.6 F.

The chemical study of the paraffin group for our purposes points, after all has been said, to the fact that liquid petrolatum, vaselin, cosmolin and hard paraffin are practically but gradations of the same body, and in fact show much resemblance in their chemical behavior. They are all absolutely neutral, and therefore non-irritant. Water, acid and alkalies have no influence upon them. By the action of bromin, chlorin and iodin, however, we get compounds which may be considered as the bromids, chlorids and iodids of the alcohol radicals and are known as the haloid ethers and the haloid esters[54]. That these or some other substitution actions may take place in the body tissues, resulting in an absorbable compound, must be considered.

Chlorin exists normally in the body tissues and forms with the other inorganic salts of the serum about six $^0/_{00}$ of the solids of the blood. Fatty matters, which, as we have seen, are also able to dissolve the paraffin, are present in the human blood to an extent of 1.4 $^0/_{00}$. Pathologically, chlorids are increased by all inflammatory processes. We might suppose that there is a local increase of chlorids near and surrounding the inflammatory process occasioned by the injected paraffin, which possibly tends to increase the substitution process in the tissues. It is obvious that in patients under treatment with bromids and iodids, who have been injected with paraffin, we have bromin and iodin coming in contact with the paraffin in the tissues. As a great many cases

of saddle-nose, facial hemiatrophy, etc., that have been injected with paraffin, are of syphilitic origin, it is not amiss to suggest the possibility of these medicinal agents being responsible for the opinion of some writers that, in some of their cases at least, the paraffin was absorbed. We grant that whatever this action is, it necessarily must be very slight, and probably takes place only in that part of the paraffin which comes in direct contact with the tissues.

At any rate, the dogmatic statement cannot be accepted that the paraffin is acted upon in tissue in the same manner as in the test tube. In the former the action is a *bio-chemical* one, of which very little is known and nothing written. In the other the action is purely a *chemical* affair.

We have inaugurated a series of experiments consisting of the administration of bromids, chlorids and iodids to paraffin-injected rabbits, to note the effect on the process of absorption.

All these very interesting chemical facts seem to have escaped the attention of the various writers quoted. What effect they may have on the final disposition of the paraffin, and to what extent their oversight has contributed to the arguments from false premises, we shall consider later.

CHAPTER III

Early Disposition of the Paraffin in the Tissues

We come now to false premise number two. Many and various are the views expressed about how, for instance, "a few hours after injection the conditions are entirely changed. A *small-celled infiltration* sets in. Soon the vaselin, like any foreign body, is encapsulated, and new tissue fibers grow through the mass so that a specimen taken from the injected area resembles an inflamed lipoma" (Gersuny); how "the paraffin globuli are grown through like a sponge and are formed into mesh-work" (Jukuff); how "paraffin stimulates the proliferation of new connective tissue cells, which invade the paraffin as they would an implanted sponge" (Moskiewitz); how "the paraffin is grown through and into by connective tissue . . . showing beginning organization of the mass" (Comstock); and how "new connective tissue and new bloodvessels permeate the mass of paraffin" (Morton), etc., etc.—all of which, it is claimed, takes days, weeks and months to occur and is described as a patho-histological process.

We shall show that this so-called early disposition of the paraffin (and herein we take issue with all other writers) *is a mechanical or physical distribution or arrangement of the paraffin in the tissues, and that it takes place immediately at the time of the injection.*

If fluids are injected into the connective, subcutaneous, areolar, or any other tissue, it is absolutely impossible, from the very histological nature of those tissues,

that the injected fluid be confined to one spot or space. Upon this principle our experiments were founded, and upon it we base our arguments. And this point seems to have been overlooked by all other experimenters.

The injected fluid, propelled by the force from behind, runs along in the direction of least resistance; forcing, stretching and tearing its way between the layers, bundles, or even single fibers or cells of the loose connective, subcutaneous or other tissue; opening up for itself paths,

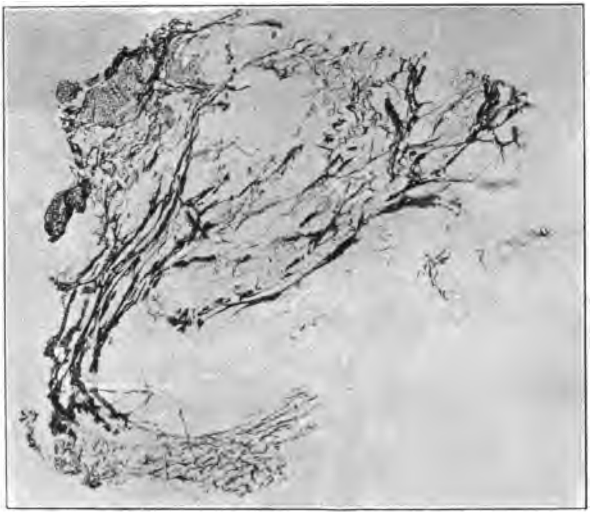


Figure 1.
Photomicrograph of a Section Removed from the Nose of a Cadaver *Immediately after injection* of paraffin in liquid state, melting point, 107 degrees F., into the subcutaneous tissue.

channels or plains, running from one alveolar space to another, encircling, surrounding and encompassing these layers, bundles, fibers or cells, collectively or singly, and even bloodvessels, *at the time of the injection.* A section removed immediately after such injection will give the appearance as though the layers, bundles, fibers, cells or bloodvessels had dipped down by proliferation or new

growth into the body of the injected substance. All this is exactly what takes place with the paraffin when injected in a melted state (fluid form) into the tissues. Most writers have stated erroneously, and tried to prove, that it takes weeks and months for this to occur.

The idea that the principle of immediate distribution or arrangement was probably correct was suggested by us five years ago, when a paraffin chunk, removed after one week's standing in the tissues in order to correct an over-injection for saddle-nose, was demonstrated before us as having alleged newly-formed tissue fibers running through its centre, "showing process of organization." We remonstrated that it was scarcely possible and hardly even plausible, that such a process could take place in so short a time; and we stated theoretically that the probabilities were as above described. We proved this at that time by making the identical injection upon the cadaver, and removing a specimen immediately after injection.

Macroscopically, the gross specimen presented large and small bundles of fibers apparently surrounded and held together by paraffin. In other words, the paraffin could not be removed in one lump as such, by itself. Altogether, it had an identical appearance with that of the piece described above, removed after over-injection for saddle-nose deformity. The mass of paraffin, *injected into the cadaver* was so thoroughly permeated by the meshwork of tissue fibers that it did give the appearance of "attempted organization!"

Microscopically, a section (see figure 1) presented: several large deposits of paraffin; farther and farther away from these large deposits there are smaller and smaller ones, with connective tissue fiber cells and the like running between and around, apparently encapsulating each deposit. As we approach nearer and nearer to

the periphery the pieces or deposits become smaller and smaller, and seem to push or crowd, and fold, pack or jam the fibers together, giving the appearance of a thickened capsule. The paraffin has been removed from the larger spaces, but in the smaller ones the paraffin crys-

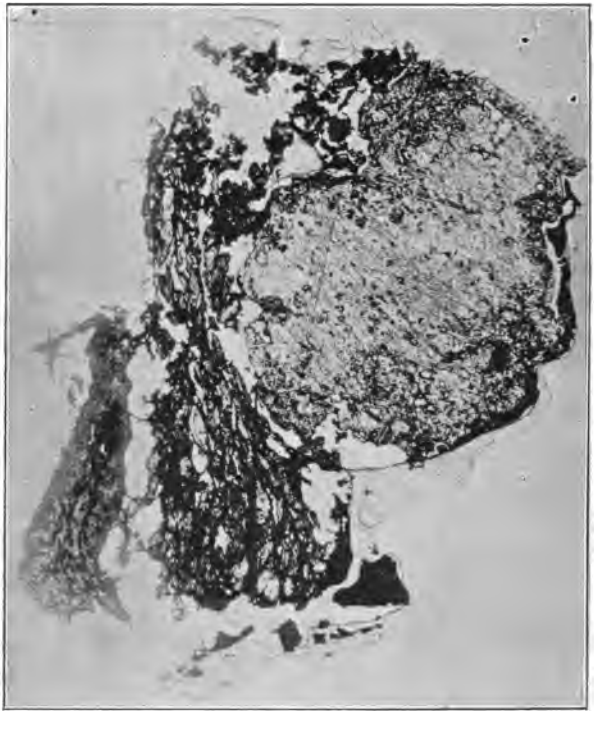


Figure 2.
Photomicrograph of a section removed from the neck (behind the ear) of a live cat *immediately after injection* of paraffin in liquid state, melting point 107 degrees F.

tals are plainly visible. (See upper left-hand corner of section.)

Figure 2 is a section of a specimen removed from the neck, just behind the ear, of a cat that had been injected

with paraffin (having a melting point of 107° F.) while in a liquid state. *This specimen was also removed immediately after the injection.*

Macroscopically and microscopically the appearance is practically the same as in figure 1, with the exception of the presence of more blood cells than in figure 1, which was removed from a cadaver. At the upper right-hand corner of the section the paraffin is laid down in one

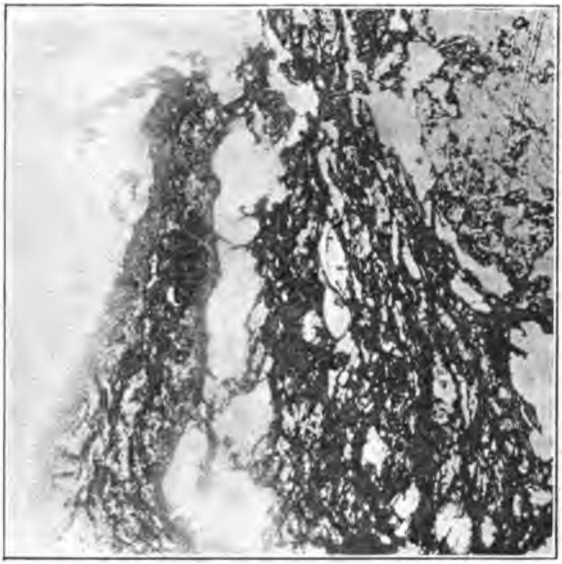


Figure 3.
Higher magnification of part of figure 2.

large or central deposit. At the lower left-hand corner the paraffin is seen in numerous finely divided particles, masses and deposits, or islands, each one of which is entirely surrounded by tissue fibers, giving the appearance as if the connective tissue fibers were endeavoring to penetrate the central mass. These particles, islands or depots, are much more finely divided and evenly distributed than the corresponding particles, islands and de-

pots in section 1. The reason for this is that figure 2 represents a section injected into live animal tissue, through which paraffin had no difficulty in spreading, while figure 1 is a section of the injection into a cadaver, just removed from the refrigerator. The tissues being frozen and minus their normal fluids, etc., the paraffin had greater difficulty in finding its way into smaller spaces along the planes of least resistance, as above described. Also the paraffin, being cooled quickly in the frozen tissues, soon left the liquid form (in which condition it could more easily disseminate) for that of the solid.

Let us now consider what has been claimed and "demonstrated" by some writers, particularly Hertel, to take place when solid pieces of paraffin are deposited subcutaneously: In describing his specimens he says that in those cases where injection was made with paraffin of a high melting point the microscopical sections showed "some proliferation and fine tissue fibers permeating the mass." "Practically the same, though much less in evidence" is what he found in those cases where solid chunks of paraffin had been implanted.

That this could be, we are somewhat at a loss for a correct explanation—for our experiments with solid chunks of paraffin, performed some time before his, did not show evidence of permeating, proliferating tissue fibers. This series of our experiments consisted in depositing several solid chunks of paraffin subcutaneously, through open incision in the necks of cats, just behind the ears. The specimens were removed in two, three, four and five months respectively.

Figure 4 shows one of these solid deposits removed after five months. The whole specimen, with plenty of surrounding tissue, was removed in mass.

A careful incision was made through to the paraffin, laying open a capsule and exposing a pocket or cavity the contents of which was our solid chunk of paraffin surrounded by a thin layer of oily fluid. The capsule presented a uniform, oily, glistening, absolutely smooth

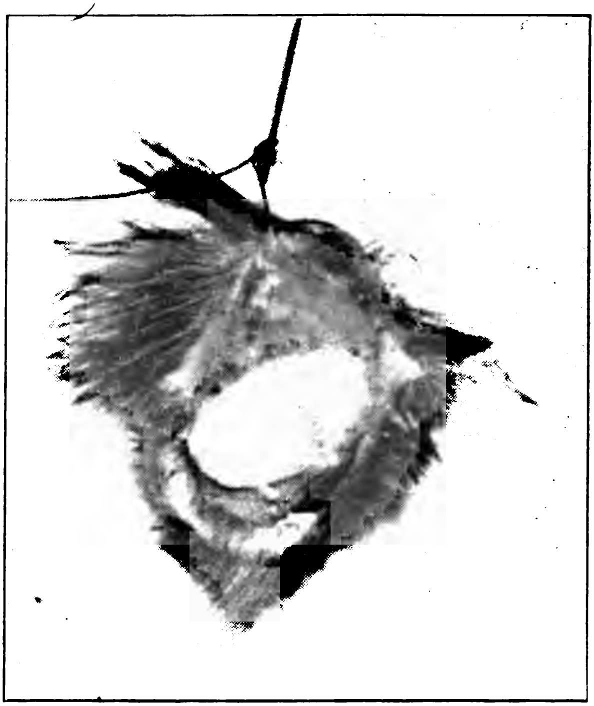


Figure 4.
Photograph of a specimen, showing solid piece of paraffin lying within a capsule, to which it is not adherent. Specimen removed five months after implantation. Slightly enlarged.

surface which was nowhere adherent to the solid piece of paraffin. Sections of the solid piece of paraffin presented absolutely no fibers, tissue, or cells of any kind. *Evidently no attempt at organization had taken place.* Section of the capsule itself presented the same picture

as that of any inflammatory capsule, only a little thicker, and the connective tissue fibers were very poor in nuclei. This thickness of the capsule is probably accounted for in part, at least, by the mechanical displacement, folding back, or pushing aside of the subcutaneous tissues, at the time of the operation, by the handle of the knife in order to make room for the paraffin.

Figure 5 is another specimen of the same series removed after five months. One month after implantation the solid chunk of paraffin was intentionally crumbled between the fingers, by pinching up the skin from the outside. This specimen was removed in mass, and the capsule carefully opened as in the other cases. Here the same small quantity of oily fluid was found, surrounding all the paraffin and separating each small chunk from its fellows. The capsule, while shining and glistening, was not so uniformly smooth as in the preceding specimen, but presented little folds or ridges corresponding to the spaces between the small pieces of paraffin. In no part, however, did it present evidences of having sent off fibers, trabeculae, etc., to grow between the separate pieces of paraffin. Here we have conclusive proof of *the disinclination of pioneer cells, fibers or bloodvessels to permeate the mass of paraffin even though, as in this case, way had been made for them.*

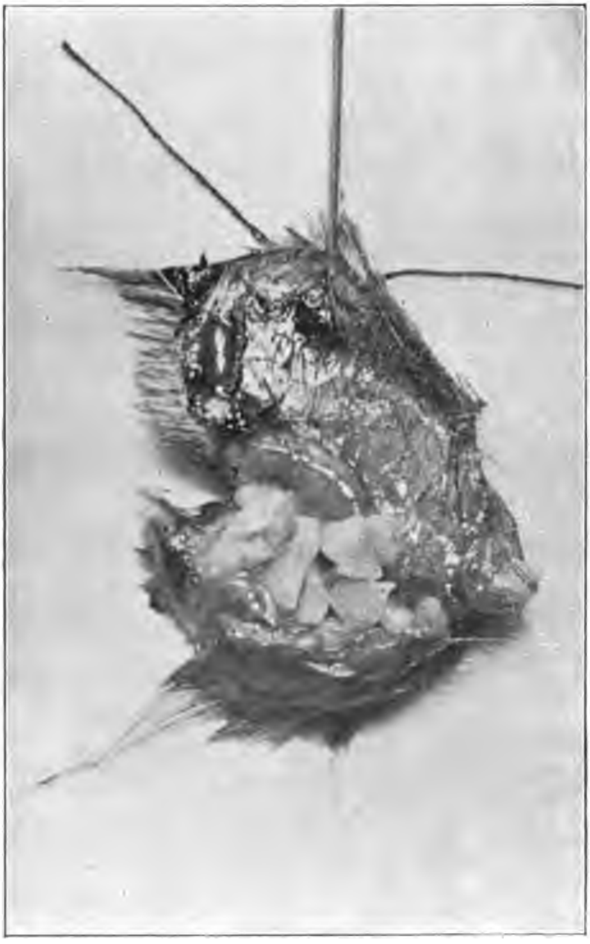


Figure 5.

Photograph of a specimen showing small pieces of paraffin that had been inserted beneath the skin in a solid chunk and crumbled between the fingers into small pieces one month after implantation. Removed in five months. No fibers or tissue of any kind to be seen within the capsule between the small pieces.

CHAPTER IV

Physical States of the Paraffin Bearing on its Disposition.

The third question that has not been given due consideration with reference to the immediate distribution of the paraffin is the *physical state* or *form* of the paraffin at the time of the operation; that is, whether it has been deposited in a fluid, semi-solid or solid form. This, regardless of the melting point, we emphasize.

We found that paraffins of varying melting points, when injected in the same fluid state (after being liquefied by heat) distribute themselves in a nearly identical manner in the tissues. But paraffins of the same melting point, if injected in different physical states, show entirely different disposition in the tissues. It is not the *melting point* of the paraffin which defines the arrangement in the tissues, but the *form* in which it is injected.

To be more explicit, paraffin of a high melting point, if injected while in a liquid state, will have an immediate distribution in the tissues like that of any fluid paraffin, such as petrolatum liquidum; and paraffin of a high melting point, if liquefied and allowed to cool to the consistency of vaselin will, if injected, distribute itself immediately in the same way as vaselin. This, of course, is true only as far as the *immediate* arrangement of the paraffin is concerned.

These conclusions were arrived at after a long series of experiments consisting of injecting paraffin of differ-

ent melting points in the same liquefied state and also injecting paraffin of the same melting point in different physical states. All of the paraffins of different melting points injected in a fluid form have the same tendency to spread evenly throughout the tissues from a central mass, which naturally has an inclination to accumulate near the tip of the needle. Sections of these are represented, in a general way, by figure 2. Paraffins of the same melting point but injected in different physical states, act entirely differently. If in the fluid state, they act as already descibed. If injected in semi-solid form, they have a tendency to be more irregularly deposited in varying sized lumps. And if only soft enough to barely pass through the needle, forced by a powerful screw syringe, they will, practically, be laid down in one large deposit. In other words, *the more solid the paraffin at the time of the injection, the more apt it is to be confined to one mass, and the less likely to spread throughout the tissues.*

As a matter of absolute fact, these statements are subject to slight modifications; for while liquefied paraffin of a high melting point in bulk is very slow to solidify, in small particles and when the temperature is reduced by coming in contact with surfaces having a lower temperature, solidifies more rapidly. Therefore the spread of liquefied paraffin of a high melting point is slightly more limited than that of paraffin of a low melting point.

THE TISSUE INJECTED

All this applies to injections into *similar tissues.* Injections into dissimilar tissues of paraffins of the same physical state necessarily present different arrangements, depending upon the amount and resistance of the loose areolar connective tissue. It makes a great difference whether the injection is made into the human body, so

rich in areolar and loose connective tissue, or into animals whose supply of these tissues is rather poor. Also there is a difference in the arrangement in the same subject, according to the varying site of the injection, for the identical reasons.

Ignoring these facts, also has contributed to misinterpretations, from which erroneous conclusions have been drawn. It accounts for the fact that authors, having made their experiments under practically the same conditions, operating even on the same animal and using paraffin of the same melting point, failed to get identical results. It explains why one writer, for instance, was somewhat disappointed and at a loss to account for the fact that a specimen, removed after three months, did not show the amount of "reorganization" that other sections for the same period had manifested. He failed to consider that the first section was removed from a deposit between the skin and cartilage of the ear of a rabbit—a site particularly poor in areolar tissue—while the other sections were taken from the flank or hip of the animal, spots rich in areolar and loose connective tissue, which tissue is easily surrounded by the paraffin at the time of the injection.

It is impossible to cut a piece of paraffin without leaving its surface covered with numerous minute cracks or crevices, which naturally offer channels of least resistance, into which tissue fibers and cells may make their way. This may account for Hertel's experience with his series of implanted solid paraffin chunks. Our pieces fail to show such ingrown tissue fibers simply because we took the precaution to make the surface uniformly smooth by passing the paraffin rapidly through the flame, thus obliterating the cracks and crevices.

Why tissue fibers and cells did not permeate the spaces between the crumbled pieces of paraffin shown in figure

5 may be explained. These interspaces between the small pieces of paraffin can be likened to the cracks and crevices on the surface of Hertel's solid chunks; but they were not produced until one month after implantation, when the initial reaction had subsided and the formation of the capsule was practically accomplished. And it stands to reason that out of the shining, glistening surface of that capsule, which is composed of scar tissue, no cells or fibers or even vessels could run into the paraffin masses. In Hertel's cases the amount of fibers and cells that found their way into the solid piece of paraffin did so through pre-existing cracks and crevices, and must necessarily have been to a very slight extent only.

CHAPTER V

Ultimate Disposition of the Paraffin

Far is it from us to wish to convey the impression, that there is no new growth of connective tissue fibers, cells and bloodvessels. On the contrary, we are well aware of the fact that there are many conditions to cause irritation and subsequent proliferation, new growth, etc. There are the heat of the paraffin, its stimulating effect as a foreign body, the mechanical injury and traumatism, and the chemical irritation of the paraffin, the combined efforts of which must necessarily cause the tissues to take on a rather violent aseptic inflammation and to make an attempt to encapsulate, as though each small particle of the paraffin were a foreign body. *But, again, our point is, that the proliferation of new tissue goes on from the already existing fibers that have been encircled by the paraffin at the time of the injection, and that the encapsulation takes place from the inside of the mass as well as from the outside.*

For how long a space of time this is continued can merely be surmised. That this process, however, is a limited one, is self-evident, as is illustrated by the fact that in none of our cases have we observed an overgrowth of the connective tissue that would in any way tend to produce a deformity by exaggerating the effect of the injection. The consideration of these circumstances leads us to a question in our study, of importance equal to, and perhaps greater than, the foregoing, for the reason that its definite settlement will determine

whether or not there is a place for paraffin as an auxiliary in surgery. We refer to the ultimate or final disposition of the paraffin.

This problem is as old as the method itself. Although the operation, as such, is comparatively a trifling one, still there are reasons in abundance for the justification of the inquiry whether the result obtained is going to be permanent.

PERMANENCY

The experience with the paraffin injections, now nearly seven years old, is not conclusive as to that. All we can say is that *the final arrangement of the paraffin* and with it *the permanence of the prosthesis, depend upon the reliability of its anchorage.* The firmer the paraffin is held down at the site of the injection the more positively it will stay there.

In the light of our former explanations the points to be considered in that respect are: (a) the melting point of the paraffin; (b) its physical state at the time of injection; (c) the site of injection as it relates to the quantity of connective tissue.

(a) Scrutinizing the work performed by the method inaugurated by Gersuny, we find many cases published where the vaselin (soft) has disappeared from the injected area. The reasons advanced are numerous. In one case of Stein injected with vaselin to correct a saddle-nose deformity, the prosthesis, and with it the cosmetic result, disappeared within a year after injection. It is stated in connection with the case that the patient, a physician, had applied massage to smooth away some uneven prominences of his prosthesis, and this accounted for the final disappearance of the vaselin. In two cases of Leiser (*loc. cit.*) injected with vaselin (soft), to correct asymmetry of the face from facial hemiatrophy, the

result, which at the beginning seemed gratifying, became unsatisfactory six months later through the manifest disappearance of part of the vaselin, so that a second operation had to be performed. The final result is not stated, neither is there any reason advanced for the probable cause of the failure. In a case of Moskovitz (*loc. cit.*) injected for a cure of an inguinal hernia, the vaselin deposit slipped down altogether into the scrotum. There are many other instances published, all tending to show that the vaselin (soft) can not be depended upon to stay where it has been deposited. It cannot even be relied upon to solidify, as shown in a case of Moskovitz, where a vaselin deposit injected into the face was after a time incised for some other reason and found in a fluid state.

All of this shows that the soft vaselin has a tendency to disappear from the site of the injection for several reasons: 1, Not being heated to the temperature required for the injection of paraffin of a high melting point it does not tend to produce a capsule as thick as that produced by the hard paraffin. 2, Not solidifying, it still is mobile, and can be moved along the plains of least resistance by gravitation, external manipulation and muscular contraction. 3, The vaselin is less irritating chemically and physically than the paraffin of a higher melting point, which accounts for the fact that each individual island of vaselin, as well as the whole mass, is surrounded by a much less thickened capsule.

The softer the paraffin the more likely is it to be absorbed or disappear altogether by oxidation, by phagocytosis or by some biochemical process not quite understood.

Fluid paraffin (paraffinum liquidum) or albolene, so commonly used as a vehicle for bichlorid of mercury injections, is taken up comparatively easily by the tissues.

All of this is likewise true of the harder paraffins, but to a much less degree, and with the very hardest paraffins it holds only to such slight extent that it hardly alters the result of the correction, and consequently is of little concern.

The harder the paraffin the richer in coal elements; hence the more irritating and less absorbable. The harder the paraffin the less the biochemical action, the more stable and lasting the deposit. The harder the paraffin the more rapidly will it cool and solidify in the tissues, thus helping to anchor itself, resisting the action of muscular contractions and outside manipulation, while the capsule is being formed. This also prevents slipping by gravitation. All of which is directly opposed to what one would expect, and what apparently does occur, when soft vaselin or paraffin is used. This does not relate to the natural dragging down by its own weight of a large deposit of any paraffin, taking all of the tissues along, the occurrence of which will be related in the report of one of our cases.

(b) Paraffin injected in a melted state will be more uniformly subdivided into small particles, each of which is encapsulated as well as the whole mass itself, thus being more firmly anchored in the tissues than paraffin that is injected in solid state, where it has a tendency to be laid down in one pocket, and is surrounded only by one capsule.

(c) For reasons already enumerated, the richer the injected site in connective tissue the more firmly will be the anchorage of the mass.

As illustrative of these conditions, we present photomicrographs of tissue sections, which were removed nearly one year after injection on account of slight deformity produced by the sagging weight of three ounces

of paraffin. Sections 6 and 7 show the sharply defined empty capsules; sections 8 and 9 were prepared with minute care. They were mounted unstained in glycerin, to prevent the dissolution of the paraffin; in spite of this, however, the globules had fallen out in some places leaving the tissue capsules empty.

The paraffin is shown here well anchored down in the surrounding connective tissue. Thick capsules encircle the globules, and the interstitial inflammatory proliferation is strongly marked.

Figure 6.
Photomicrograph of tissue section one year after injection, showing large capsules from which the paraffin had been removed.

Figure 7.
High magnification of figure 6.

Figure 8.
Enormous amount of paraffin imbedded in connective tissue. Section made one year after injection.

Figure 9.
High magnification of figure 8, showing very clearly the paraffin crystals.

CHAPTER VI

TECHNIC AND INSTRUMENTARIUM

Selection of Paraffin Mixture

The various facts elucidated have prompted us to take up from the very beginning the use of paraffin of a melting point from 107° F. to 115° F., according to the effect to be obtained, the site of the injection, the resistance of the tissues and several other factors which might present themselves in the individual cases. One cannot obtain the best results by the persistent use of paraffin of a particular melting point, but should always be supplied with specimens of varying degrees of hardness. In a general way, where the edges of the deposit are to be sharply defined, such as a depressed scar, we use paraffin of the highest melting point; where the outlines of the deformity blend gradually with the normal tissues paraffin of a lower melting point is used. In other words, for reasons already enumerated, we can control the spread through the tissues of paraffin of a higher melting point more easily than we can that of a paraffin of lower melting point. Again, experience has taught us that hard paraffin should never be injected into dense, cicatricial, inelastic tissue or any tissue poor in connective elements. The tension necessarily produced does not have a tendency to let up in the harder, therefore more stable, deposit, whereas in the softer paraffins we have a greater extension throughout the tissues by the force of the tension itself. It is not the paraffin that gives way, but

the skin; and if this is bound down too tightly, we must employ a product that will have a tendency to move, thus causing the tension to let up.

Preparation of the Paraffin Mixtures

Hard paraffin (paraffinum durum), melting point 110° F. up to 166° F., and fluid paraffin (paraffinum liquidum), commonly called liquid petroleum or albolene, are always easily available. By combining these in varying proportions we produce our specimens of required melting point. We have never used vaselin in any of our preparations. We cannot give exact proportions of the mixtures of hard and fluid paraffin to produce an article melting at a given temperature, and it is only by most tedious and rather crude experimentation that we arrive at a desired melting point.

Testing the Melting Point

Melt the mixture, float a drop on the surface of a glass of hot water, and note the temperature of the water when the drop strikes white; heat up the glass of water and note the temperature at which the floating drop of paraffin remelts. The mean between the two temperatures, roughly speaking, is the melting point of the paraffin. The bulb of the thermometer should be held as near as possible to the drop of paraffin.

If the melting point is not satisfactory, add solid or fluid paraffin, according as it is desired to raise or to lower the melting point of the mixture, and retest.

In preparing a specimen for injection into very dense cicatricial tissue substitute olive oil for the fluid paraffin, and proceed as above.

Instrumentarium

The instrumental outfit we use is a very simple one; we have never had any reason to depart from our original

apparatus during five years of experimental and clinical work and, indeed, the instruments we employ to-day are the same ones with which we injected our first case.

There are various paraffin syringes on the market. Experience shows that the ordinary Pravaz syringe suggested and used by Gersuny and his followers does not answer the requirements of a good paraffin syringe. It will suffice for the injection of fluid, but not for the harder paraffins, and its packings and washers will be damaged by repeated sterilization. Eckstein[55] places a rubber tubing over his syringe to prevent heat radiation, thus keeping his hard paraffin melted. For the same pur-

Figure 10. Harmon Smith's Paraffin Syringe.

pose A. von Pfluk[56] has invented a syringe surrounded by a jacket of continuously circulating hot water. Quinlan[57] has a similar syringe. To prevent solidification of the paraffin in the needle Walker Downie[58] winds the outside with a fine platinum wire, which is kept heated by connection with a storage battery.

All these instruments, with their numerous modifications, have one or another advantage over the devices previously in use; they are, however, not without fault, the least objection being that, owing to their more or less complicated mechanism, they are very clumsy to handle and difficult to control. Moreover, it is easy to dis-

pense with them, for in Harmon Smith's syringe, which is a modification of that originally, constructed by Heath[59], we have an instrument that will answer all the purposes which it might be called upon to serve. (Figure 10.)

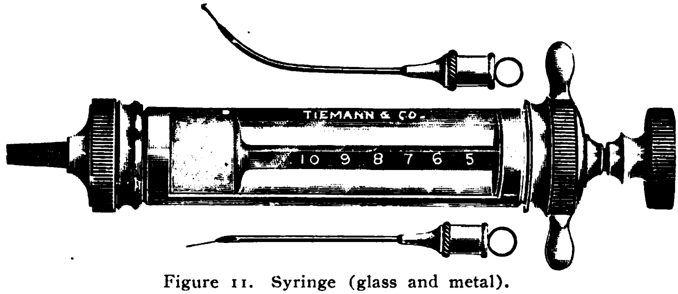


Figure 11. Syringe (glass and metal).

This syringe consists essentially of a solid metal barrel with a small threaded nipple at one end for the needle, and fitted with a solid metal plunger to which is attached a strong threaded plunger-rod. This plunger-rod and its screw threads fit into a strong screw-threaded cap at the top of the syringe, which in turn fits into a larger cap, screwed on to the top of the barrel. This arrangement allows one to either push the plunger in with the thumb

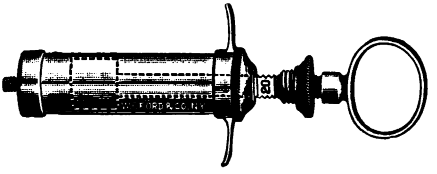


Figure 12. Smith's Syringe.

as in an ordinary syringe, or, by gradually turning the plunger-rod, to force forward the plunger with a steady, sure and powerful pressure. The washer between needle and syringe is of soft metal. There being no other washers or packings the syringe is capable of indefinite sterilization without risk of its destruction. (Figure 12.)

In Yankauer's clever modification of Smith's syringe (figure 13) to prevent the intermediate collar or ring from being jammed between the piston-rod and the cap of the barrel, the collar has been fastened to a plate, provided with two bent arms, which interlock with two similar arms projecting from the top of the cap. The collar can be easily disengaged for the purpose of filling the syringe, etc. The rotation of the piston-rod, in injecting the paraffin, is rendered more uniform and easy by having the piston-rod jointed to the piston proper, instead of being rigidly attached thereto, as in the original model.

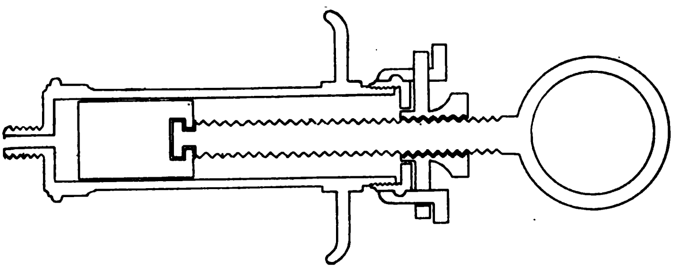


Figure 13. Yankauer's Modification of Harmon Smith's Syringe.

An ordinary straight, strong needle (figure 11) about 2½ inches long is usually sufficient. Rarely have we been compelled, from the peculiar site of the injection to use a curved needle. (Figures 11 and 14.)

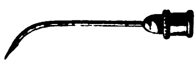


Figure 14. Curved Needle.

For injections of very large amounts of paraffin we have used the syringe illustrated in figure 15. This syringe is fitted with asbestos packings and may be repeatedly boiled.

A small vessel for the liquefaction and boiling of the paraffin completes the instrumentarium. There are sev-

eral fancy cups on the market for that purpose. (Figure 16.) We use a thin glass beaker, holding about three ounces, which is surrounded at the top by a lead band to prevent its floating, when seated in the water bath. (Figure 17.)

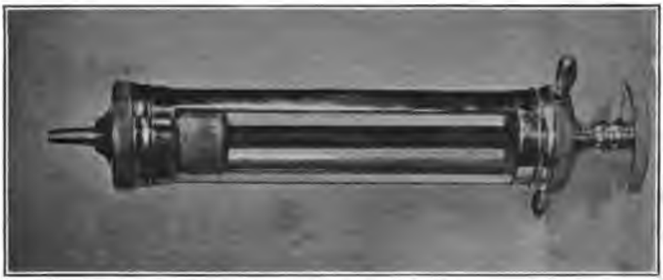


Figure 15. Syringe with Asbestos Packing for Injection of Large Amounts of Paraffin.

Technic

Having selected our paraffin mixture according to the melting point suitable for the individual case, it is placed in the glass beaker and allowed to boil for twenty minutes. Operator and assistant are prepared with all the aseptic care as though any major operation, opening of the peritoneal cavity even, were to be performed. The field of operation is scrubbed with soap and water, washed with ether or alcohol and then with some antiseptic solution. A square of sterile gauze with a hole in its center is placed over the site of injection.

In general the syringe is filled from the top after removing the screw-cap and piston, the melted paraffin being poured from the beaker into the barrel. Care is taken to first pour off the scum or other floating particles, which, in spite of all precautions, will be found on the surface of the paraffin. The piston is then inserted and the cap screwed on. In this way one need have no fear

of the presence of air bubbles in the syringe. The syringe, with the needle attached, is now laid in a basin of hot antiseptic solution, preferably 3% carbolic acid, and the paraffin allowed to cool to a desired physical state, depending upon the individual case. Sometimes, if allowed to cool too much, the paraffin will plug up the needle. This can readily be obviated by dipping the needle into a very hot solution immediately before it is inserted under the skin. In the case of the very large syringe that has no screw-threads to force along the piston against the solid column of paraffin in the needle, which

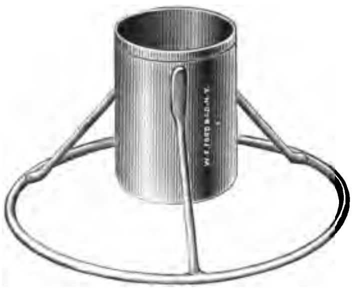


Figure 16. Metal Paraffin Cup.

Figure 17. Glass Beaker used by the Authors for Melting Paraffin.

cools very rapidly, we have found it a very useful expedient to draw into the needle a few drops of very hot

liquid petroleum. This precaution keeps the needle warm and insures against the solidification of the paraffin in it, provided the piston is kept moving steadily forward until the syringe is emptied.

Now we are ready for the injection. Insert the needle beneath the skin into the subcutaneous tissue, passing the point beyond the center of the proposed deposit; steadily and firmly inject the paraffin as the needle is being slowly withdrawn. If the deposit is considered satisfactory, remove the needle and apply collodion to the wound.

Much can be said for and against the use of anesthetics and analgesics. Suffice it to say that we have never found either necessary.

Equally as important as the operator is the assistant; for upon his knowledge of the directions of least resistance and the precautions that he has to take to prevent the paraffin from following these channels, together with his judgment and artistic eye, depends the success of the operation, from both a cosmetic and a surgical standpoint. And we are prepared to assert right here, that in any number of failures, where the result was spoiled by the shifting of the mass, the blame might easily be lodged on the inadequate assistance rendered to the operator. Take, for example, a case of saddle-nose deformity. One little jerk of the piston is apt to shoot up a mass of paraffin towards the inner canthi of the eyes, if the vigilant assistant fails to exert the necessary pressure upon the sides of the nose to prevent just such an emergency. It is the same while injecting depressed scars, notably on the face, where one drop of paraffin out of the right place is sufficient to spoil the cosmetic effect, and it is perhaps due to the thorough training of our helpers that no untoward conditions ever disturbed the satisfactory results in our cases.

CHAPTER VII

UNSATISFACTORY RESULTS

It must be evident, that having to deal with a delicate procedure, where one drop in excess may spoil the effect of work ever so tedious, unsatisfactory results may easily be produced.

CAUSES OF FAILURE

One cause of failure has been given in inadequate assistance. There are others; they become, however, more or less easily avoidable as experience teaches the operator to make the proper selection as to quality and amount of paraffin suitable in the individual cases.

The first cause of failure in an otherwise well managed case might be the *escape of the paraffin after withdrawal of the needle.* The precaution to paint the puncture wound with collodion will not always preclude such an emergency. To obviate it we are in the habit of using ethyl chlorid spray rather freely over the injected area *while the needle is in situ,* and to impress the patient with the importance, subsequently, of keeping his hands off the prosthesis.

Infection, with subsequent abscess-formation and expulsion of the paraffin deposit, is another not infrequent cause of failure. This, however, ought to be easily avoided, if judicious care is taken both before and after the operation.

Deformity from overinjection is frequently met with in the reports, especially in the first cases of the various

authors, the cause of it being almost invariably lack of experience. It is quite erroneous to assume that every correction must be made in one sitting; especially so in cases where the site of injection is rich, in loose connective tissue. Just in these cases it is more judicious to deposit one good lump of paraffin and build up the prosthesis on that basis with subsequent small injections. Although not always avoidable, the necessity of excising over-corrections should be reduced to a minimum and it is better policy to inject a dram of paraffin too little than a drop of it in excess.

Aside from the cosmetic failure due to overinjection the introduction of more paraffin than the individual case is apt to bear might lead to more serious damage, as the excess of pressure, by cutting off the blood supply will induce *necrosis* with all its consequences. Wasserman's[60] sad experience in a case of saddle-nose deformity is very instructive in that respect. Two and a half ccm. of vaselinum purissimum album, with a melting point of 104° F., were injected, a comparatively small amount, and yet it proved excessive. Next morning the patient awoke with violent pain; the nose as well as the surrounding parts of the face, especially the eyelids, were considerably swollen; the back of the nose showed a dark blue discoloration. Two days after injection distinct demarcation; the skin over the nose was necrotic and it subsequently sloughed off. An ultimate skin-grafting saved the appearances.

Practically the same happens, though perhaps to a lesser degree, *from injection of the paraffin into the skin proper,* instead of into the subcutaneous tissue. An intense redness of the skin is the first sign of the onset of a violent inflammatory reaction terminating as a rule in sloughing of the superficial skin layers and extrusion of the paraffin.

Some superficial sloughing of the skin has also been reported as a consequence of *excessive heat of the paraffin and of burns from a too hot needle.* These, however, are easily coped with by applications of liquor Burowii or similar antiphlogistic agents.

Injection into very dense, inelastic structures or into cicatricial tissue firmly attached to the underlying and adjacent parts, is equally apt to cause failure. In the first of these conditions Gersuny[61] suggests the use of a mixture of four parts of olive oil to one part of vaselin; in one of our cases of "lorgnette saddle-nose" (Case 13), we used a 3:1 albolene-paraffin mixture, with good result. In the second condition, as represented by scars after operations on bony structures (Cases 17 and 18) we first liberate the adherent skin with a tenotome and then fill up the defect with paraffin.

CHAPTER VIII

Accidents

The chapter of accidents due to paraffin injections merits serious consideration. Although the fatal cases reported number but one—Hertel's two rabbits not included—and the total number of accidents is very small compared to the thousands of injections made during the last six years, still the fact of their occurrence, itself, urges the need of making a thorough study of the circumstances which led up to them. To detect the evil is the first step towards avoiding it.

The accidents reported in the current literature number—according to Heath[62]—nine. Evidently the latter took his information from Eckstein, because in the articles of both of them we see the same errors committed. A careful search of the *Centralblatt für Gynaekologie,* Nov. 27, 1902, and of the *Revue hebdomadaire de Laryngologie, etc.,* July, 1903, given as sources of information concerning Halban's[63] and Broeckaert's[64] accidents, respectively, failed to reveal any reported accidents. Halban reports four cases of cystocele with perfect result; no accident is mentioned, unless it was by oral communication to Eckstein, who, however, does not hint at such a fact. All Broeckaert says in the article referred to, is to the effect that he sometimes noticed a slight *edema* after correction for saddle-nose, but he did not attribute to that much significance. Hertel's accidents, as mentioned before, were in rabbits, and happening under altogether different circumstances, they ought not to be taken into consideration.

This leaves a balance of six genuine accidents, which will be considered in their chronological order.

1. *Embolus of the left lung and probably of the brain.* Pfannenstiel (loc. cit.). A case of incontinence of urine due to extirpation of the urethra for cancer. He used a mixture of hard paraffin and white vaselin having a melting point of 45° C. (110° F.). Amount 30 ccm. On her way to the ward the patient was suddenly seized with nausea and coughing; soon a chill set in, followed by vomiting, headache, dyspnea and a slight rise in temperature, and pulse rate. A careful examination of the lungs proved negative. On the third day after injection the patient complained of violent pain in her left side and percussion revealed an area of dullness in the lower lobe of the left lung. There were also bronchial breathing and tenaceous, bloody expectoration. From the sixth day on, however, she made a good recovery.

2. *Embolus of the lungs.* Kapsammer[65]. Report of two cases injected by von Frisch for incontinence of urine. Injection of 12 ccm. in two sittings in both cases. In the first case, immediately after the second injection there developed tenesmus, sensation of the presence of a foreign body in the vagina and a rise of temperature to 101° F. The symptoms, very suggestive of the formation of an embolus, passed rapidly away, however, leaving the question unsettled. The second case was more characteristic. Soon after the second injection, chills, headache, dyspnea and cough set in with a rise of temperature to 101.5° F. Severe pain in the left lung, about one inch outside of the apex beat, was complained of, but no objective manifestation was traceable. In five days the patient was well.

3. *Embolus of the lungs with fatal result.* Kofman[66]. The woman was suffering from endometritis granulosa and prolapse of the uterus. Curettage. Two weeks

later injection of paraffin. Scarcely 20 ccm. had been injected, when the patient suddenly started to cough. Twenty-four hours later death, caused by embolus of the lungs.

4. *Embolus of the lungs.* Gersuny. (a.) Case of prolapsus uteri. Injection of 30 ccm. of vaselin into the parametria. The following day pain in the chest and rise of temperature. Pneumonia of the lower lobe of both lungs. On the eleventh day thrombosis of the left vena saphena major. Recovery. (b.) Anterior and posterior prolapse of the vagina; descensus uteri. Injection of 20 ccm. of vaselin into the parametria of each side and of 10 ccm., each into the anterior and the posterior vaginal walls. Total amount used, 60 ccm. The following day, rise of temperature and pains in the chest. A subcutaneous injection of morphine is followed by a severe collapse, from which the patient is rallied with the utmost difficulty. Bilateral pneumonia of lower lobes of lungs, followed later by exudative pleurisy on the right side. Recovery.

In connection with these cases, as a matter of possibility, we wish to record here, suggestively, one of our experiences which will serve to illustrate very strongly the possible occurrence of fatal coincidence.

Sadie H., three years old, was referred to our dispensary department from Dr. Henry Heiman's clinic, for injection of an umbilical hernia. The child had been treated for a slight enterocolitis, from which it had practically recovered. A thorough inspection in the examination-room showed the patient to be in a fairly good physical condition. Immediate operation having been decided upon, the child was conveyed to the operating room, and put on the table; and it was being prepared for the injection when the assistant noticed the child tremble slightly. This at first he mistook for the naturally frightened condition of the baby. Immediately afterwards, however, marked cyanosis supervened, followed

by collapse. We thought this condition might be due to some remedy containing a cardiac depressant, and we sent for Dr. Heiman. His assistant, who responded, stated that nothing had been given to the baby in the way of drugs. Thereupon we refused to operate and referred the child back to Dr. Heiman's clinic, where a more careful examination failing to reveal the cause of the sudden change in its condition, the little patient was transferred to the hospital for further observation. The following day all the symptoms and physical signs of a well marked pneumonia were present.

What a narrow escape! In a few moments we would have been making our injection; and no amount of argument or earthly persuasion would have exonerated us from having caused the collapse. We ourselves would have been inclined to the belief that an accidental lung embolus had been produced by the paraffin injection.

5. *Amaurosis of the left eye caused by thrombosis of the ophthalmic vein.* Leiser[67]. Case of saddle-nose deformity. Total amount injected in three consecutive sittings 4.5 ccm. Mixture used of a melting point 110° F. Immediately after the third injection severe collapse, vomiting, persisting for hours (irritation of the brain), complete amaurosis of the left eye caused by thrombosis of the left ophthalmic vein.

6. *Amaurosis of the right eye caused by thrombosis of the arteria centralis retinae.* Hurd and Holden[68]. Correction for saddle-nose deformity. First injection, October 5, 1902; second sitting, November 17, 1902; final sitting, leading eventually to accident, April 27, 1903. Mixture used of paraffin and white vaselin of a melting point of 110° F.; its physical state at the time of injection semisolid. The needle was introduced first at the tip of the nose and pushed upward an inch, then introduced at the root of the nose and pushed downward to a spot just above the former injection. "At this time the patient was seen to rub his right eye, and in reply to a

question, he said that he could not see with it." Somewhat later ecchymoses appeared about the tip of the nose, indicating that a vein had been punctured. Twenty-five minutes later ocular examination revealed embolism of the arteria centralis retinæ.

That in some of these accidents, notably the cases of amaurosis, unfortunate circumstances were predominant, no impartial critic will deny; and it is rather astonishing to hear Hurd and Holden unconditionally condemn the procedure, in the face of the fact that they happened to come across what probably was a case of persistent foramen ovale between the two auricles of the heart. This is what they have to say on the subject:

"Leiser believed the amaurosis in his case due to thrombosis of the ophthalmic vein, into which runs the vena dorsalis nasi, which might have been punctured in the operation. Thrombosis of the ophthalmic vein far back of the cavernous sinus, into which it enters, might have accounted for the symptoms observed, *but it is remarkable* that a foreign body entering a small vein should pass centripetally toward the heart and be caught in a vein of much larger caliber. *The pathological conditions,*" they say further, "*are no clearer in our own case,* since a foreign body voluminous enough to block the large central artery and resist all efforts to force it along into a smaller branch, can hardly be supposed, after entering a vein, to pass through the capillaries of the lungs and back to the left side of the heart and thence into the general arterial circulation."

But even assuming that this would be the regular proportion of accidents among so many thousand injections, it could easily stand comparison with some statistics of mercury injections, showing as high a proportion as 8.9 per cent. of embolism.

That as soon as the first accident occurred, ways were suggested to avoid such emergencies, is but natural. Gersuny suggested infiltration of the site of injection by Schleich's method prior to the injection of the paraffin in order to avoid the puncture of a vein. Stein attributed the occurrence of emboli to the fluid state of the vaselin at the time of injection and advised against injecting before it has obtained a semifluid or pasty consistency. Lesser[69] advised unscrewing the barrel from the needle after it is introduced at the site of injection—if blood comes out through the needle, this ought to be taken as proof that a vein was entered and the needle must be withdrawn.

It is probable that Gersuny observed at least his own precautions after the first accidents were recorded, and still shortly afterwards there were two cases of lung embolus, proving the futility of the measures suggested by him and Moskiewitz. True, they had used 30 and 60 ccm. respectively, in their two cases; and they hint at that fact with the latent understanding that the large amount had possibly to do with the mishaps. But in Kofman's case not more than 20 ccm., in Kapsammer's cases about 12 ccm., in Leiser's about 4.5 ccm., and in Hurd's case certainly not more than 1 to 2 ccm. paraffin were used, so that it does not seem plausible that the amount of the injected material is to be held responsible.

In consideration of the fact that in all these cases vaselin, paraffin, and mixtures of a melting point from 90° to 110° F. were employed, and that, on the other hand, there was never an accident reported from authors who, following the advice of Eckstein, used hard paraffin of a higher melting point, it is highly suggestive that the formation of emboli may be attributed to the low melting point of the mixtures.

In some cases the emboli occurred some time after the injection, in Gersuny's cases the day following; and this fits promptly into the reasoning of Eckstein, who says, and has proved it, that mixtures up to 110° F. (the latter figure is probably the limit), even if injected in semi-solid physical state, do not retain their pasty consistency in the body. If the vaselin of a melting point up to 105° F. is cooled down in the syringe to the consistency of a semi-solid thread, which it only attains at a temperature *below* that of the body, and is then injected, it naturally melts again into a fluid state as soon as it is deposited in tissues having a higher temperature. Even a mixture with a melting point up to 110° F. is at 99° F. as good as fluid, and as conclusive proof Eckstein cites the case of Gersuny, mentioned in one of our previous articles, where vaselin introduced into the pterygo-palatine fossa was a year later found to have remained in perfectly fluid state.

Mishaps of the kind never occurred in any of those thousands of cases in which hard paraffin was injected. True, this also has to be injected in a fluid or semi-solid state; but owing to the tremendous cooling down it encounters immediately upon entering the body, it solidifies rapidly, almost instantaneously, taking up a consistency that no blood current is able to alter. If injected directly into a small vein, the hard paraffin will plug it and the inpouring stream of paraffin, bound to settle down in one big lump, compresses the vessel from every side to an extent that no parcel of the mass can be carried into the circulation.

It is just this property of immediate solidification which, apparently, prevents accidents while using hard paraffin, and which, should the injection be done in very vascular regions, enables us to profit by a prophylactic measure utterly useless when soft material is employed, viz., the production of temporary anemia by adrenalin or

suprarenin, as suggested by Eckstein. Vaselin and soft mixtures held in liquid state by the body temperature are apt to be just as dangerous, as to the possibility of parcels of them being carried into the circulation, after cessation of the artificial anemia, as they were before; while the hard paraffin must have consolidated in the meantime to a consistency that is quite innocuous.

To summarize briefly, we are entitled to say that accidents, although comparatively very rare, have occurred in cases where paraffin mixtures with melting points ranging from 90° *F. up to* 110° *F. have been used, and that the best measure to avoid mishaps of this dangerous character is to use hard paraffin with a melting point above* 110° *F.*

PART II

PART II

CASUISTICS

The clinic and private material, on which this study was based, embraces sixty-four operated cases. It is not very varied, only a few out of the vast array of indications for paraffin injections being represented. The general practitioners, apparently, have not recovered sufficiently from the shock of those few mishaps, which were broadly reported and dwelt upon, and the manifest utility of the procedure has failed so far to win their confidence. Those cases of saddle-nose deformity, which cannot be approached by any other treatment, are readily submitted to the operation. They number thirty-five in our total, a considerable percentage if one considers the fact that our clinic is one of general surgery. Most of the other cases had been treated previously by different physicians and by various means, and the paraffin treatment was really resorted to as a sort of ultimate refuge. We earnestly hope that our successes in this series will do something towards establishing paraffin as an auxiliary in surgery and that recourse will more often be taken to a procedure, which has proved to be—to all ends and purposes—as satisfactory as it is innocuous.

Elsewhere in this monograph we classified the indications for paraffin injections into two groups, viz., 1, functional, and 2, cosmetic improvements.

Under the first heading we have represented in our material:

Incontinence of Urine...... 2 cases (1-2);
Umbilical Hernia ....17 " (3-19);
Umbilical and Ventral Hernia 1 case (20);

Epigastric Hernia .... 1 " (21);
Inguinal Hernia .... 1 " (22);

Under the second heading:

Depressed Scar............ 6 cases (23-28);
Hemiatrophia Facialis ...... 1 case (29);
Saddle-Nose Deformity.....35 cases (30-64).

A. FUNCTIONAL IMPROVEMENTS

Incontinence of Urine in the Female (Two Cases).

Cases of incontinence of urine in the female, where the urethra is intact, have, without exception, shown good results after paraffin injections. Kapsammer (*loc. cit.*) reported as early as 1901, two cases of von Fritch, both of which were greatly improved by the treatment and remained so. Numerous publications of German and French authors are all unanimous in that respect.

The task, however, is more difficult in those cases, where, for gangrene or malignant processes, the urethra has been entirely or partially excised; and as the good or bad result depends largely upon the technic, as shown in two cases of Gersuny and Pfannenstiel, respectively, we do not deem it out of place to dwell here upon the history of those two cases and the controversy they led to.

Gersuny's case refers to a woman, twenty-five years old, who, since her first confinement (in 1895), had a large vesico-vaginal fistula. The closure of this defect having been obtained through operation, the vesical sphincter became paralyzed; torsion of the urethra followed, with subsequent gangrene, and the dripping of the urine started over again. It was then that Gersuny saw the woman. In the following two years six different operations were resorted to in order to cope with the situation; the result each time was but slight and of short duration. In 1900 the patient's status was as fol-

lows: In the recumbent position, no dripping for a few hours; sitting, walking and standing produces continuous flow of urine. The vestibule showed at the level of the neck of the bladder a hole big enough to admit easily the little finger up to the base of the terminal phalanx. Through this hole two folds of the vesical mucous membrane, about the size of a pair of beans, were protruding, which could easily be replaced, and which, by obliterating the hole, retained the flow of urine, while the patient was lying on her back. Under cocain anesthesia (5%) some Unguentum paraffin was injected into the prolapsed folds; the thus enlarged protrusions were now replaced with some difficulty and did not prolapse again. More paraffin was then injected into the sub-mucous tissue of the bladder around the orifice of the urethra, the needle being introduced through the mucous membrane of the vestibule and the vaginal wall bordering the vesical ostium. Three and five-tenths ccm. of ung. paraffin being injected, a coarse ring could be felt underneath the vesical mucosa, encircling the vesical orifice; and the mucous membrane closed the former hole. Water introduced now into the bladder was retained. In the next few days the dripping started again, whenever the patient was standing or walking, while in the recumbent position continence was perfect. Eight days later 2.5 ccm. paraffin ointment was injected into the ring, the needle being introduced in several points around the bladder neck. On the fifth day the patient could hold her water for 1½ hours while walking around. The improvement continued, however, so that three months later the bladder was continent for 4 to 6 hours and was able to retain 350 ccm. of urine.

Pfannenstiel's case shows almost identical features. The urethra had been extirpated for cancer and the vestibule, on a point corresponding to the neck of the bladder, carried a hole large enough to admit the little finger,

through which particles of mucous membrane are protruding. And still the injection of paraffin proved a failure in so far, as the condition of incontinence remained the same.

The difference in the result in those two cases is due, as Moskiewitz very cleverly explains, to a slight omission on the part of Pfannenstiel; he neglected to replace the mucous folds after injection into the bladder, hence no continence could be obtained.

In Gersuny's case the injected folds were immediately replaced; a subsequent injection around the bladder neck, narrowing the original hole, insured their remaining in the bladder. In this way the internal pressure in the bladder tended to approximate them and their incarceration in the vesical orifice was responsible for the continence. (Figure 18.)

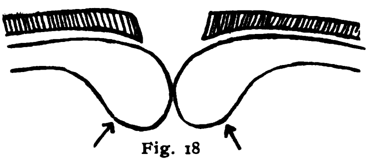


Fig. 18

In Pfannenstiel's case the injection was equally followed by a reduction of the size of the defect. The hole, which before had admitted the little finger, would scarcely admit a sound of small caliber. But there was no continence, *because the mucous folds had not been replaced.* In spite of having used five times the amount of paraffin, Pfannenstiel did not obtain the valve-like action of the mucous folds; the stenosis produced by the injection was well able to obstruct the defect from the outside, but it could not withstand the pressure from the inside, which necessarily tended to stretch the folds apart. (Figure 19.) Gersuny produced a valve *closing* towards the outside, while Pfannenstiel made one *opening* in that direction.

Our own cases operated upon for incontinence of urine are the following:

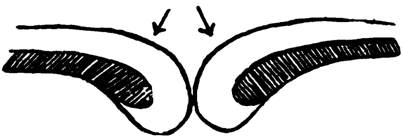


Fig. 19

CASE NO. 1.—Henrietta D., 56 years old (Mount Sinai Dispensary Record No. 1979—1905), was referred to the clinic by Dr. W. M. Brickner on March 17, 1905. *History:* Following instrumental delivery fifteen years ago, patient has had incontinence of urine. Wets herself frequently during the day. Urine does not flow out continuously, but at irregular intervals day and night. While the patient does not have a desire to urinate nor warning, she feels the escape of the urine. Is able to urinate voluntarily. Urine escapes in spurts when coughing, sneezing or making any muscular effort that increases intra-abdominal tension. *Examination:* Patient involuntarily urinated while lying on the table. The vaginal outlet is relaxed. Excoriation of urine-soaked labia and buttocks. Old laceration of perineum. Slight cystocele and rectocele. Wide open, gaping urethral meatus. Urethra about 2 inches long, freely admitting a No. 35 French sound, the largest instrument at hand; could easily admit a larger sound. No sacculation of urethra. Apparent complete relaxation of vesical sphincter. Uterus and appendages normal. Bladder wall normal. Urine clear; no albumin; no sugar. *Operation,* March 17th: Vagina and field of operation thoroughly prepared. A No. 20 French sound inserted into bladder and held in position by an assistant. Labia retracted on each side; index finger of left hand placed under vesical sphincter per vaginam; needle inserted through vaginal wall about one inch posterior to meatus urinarius, passed along septum urethro-vaginale until it touched tip of left index finger, where a deposit of paraffin (M. P. 120° F.) was made, the needle being so manipulated as to insure, as far as possible, a circular deposit around the neck of the bladder. The injection was con-

tinued until it was plainly noticeable that the sound upon manipulation was fairly well grasped, about two drams of paraffin being injected. Immediately following the operation, absolute continence; coughing, sneezing and other muscular efforts failed to cause leakage. April 14th: Ever since the operation control over bladder perfect. At the last report there was the same perfect condition.

Case 2.

S. A.—Admitted to Mount Sinai Hospital. Dr. Gerster's service, Oct. 31, 1905.

Twenty months ago, following instrumental delivery, had incontinence of urine. Unable to hold urine at any time, standing, sitting or lying down. No less than six plastic operations have been performed on the urethra. Some of the operations afforded temporary relief only.

Present Examination.—Relaxed vaginal outlet, relaxed urethra, easily accommodating a 40 F. sound and more; the little finger can easily be inserted into the urethra. Bladder holds ℥x when patient is on back. Urethra-vaginal septum is one mass of cicatricial tissue.

Operation, Nov. 13, through courtesy of Dr. Gerster, without anaesthesia. Needle inserted near urethral meatus into urethro-vaginal septum down to neck of bladder and ʒiss of Paraffin, M. P. 135° F., injected until a 24 F. sound was firmly grasped in urethra. Nov. 16 patient discharged improved. On lying or sitting urine retained, but still has incontinence while walking.

This patient has subsequently passed from our observation. Undoubtedly another injection would greatly improve if not entirely relieve her distressing condition. Owing to the enormous tension on injecting paraffin into dense cicatricial tissue we were prohibited from injecting at the first sitting as much paraffin as we would otherwise have done under ordinary conditions.

Umbilical Hernia

(*Seventeen Cases*)

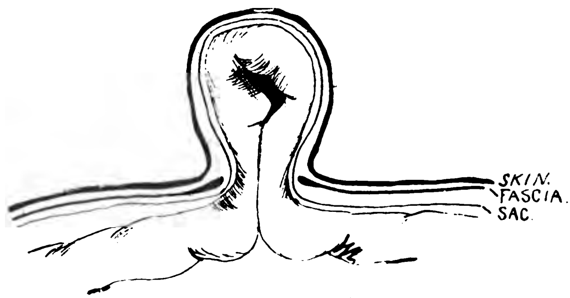
The treatment of congenital umbilical hernia in children, until the employment of paraffin, consisted of strap-

ping with adhesive plaster, with or without the use of a button, or some form of mechanical truss. In the overwhelming majority of the cases the strappings had to be, and actually were, carried on for weeks and months with numerous renewals; they became loose or displaced and always provoked an irritation or inflammation of the skin. Each change of dressing and every let-up necessitated by these conditions promptly restored the hernia and nullified the result of all previous efforts. Mechanical trusses proved even more encumbrant. Half rounded or pointed buttons, though answering the purpose of occluding the hernial opening, acted naturally against a spontaneous closure of the hiatus; while flat trusses became easily displaced.

It was an awful tangle—as Escherich[70] puts it—and it is to his everlasting merit to have shown us a way out of it. In a brilliant article on the subject, he gives a vivid description of his experience. He has operated on thirty children at the ages of from two to fourteen months; one child was at the age of five years. According to the size of the sac he injects 1.5 ccm.; after hardening, the paraffin is felt as a compact, not displaceable pad underneath the skin, covering the hernial opening and overlapping it from every side. The pad thus established is formed in such a way that the paraffin injected into the emptied hernial sac expands throughout the dome of the sac in the shape of a *calotte,* the upward pressure of the reappearing hernia, and the quick solidification of the mass, prohibiting its sinking down in the abdominal cavity. A circular bandage is applied over the site of injection, and under the pressure of this the still plastic mass is formed into a flat button, which, after cicatrization, will serve as an ideal subcutaneous truss, favoring complete occlusion. Escherich found the results best in cases, where the hernial opening did not exceed ½-1 cm.; if the opening is larger, it is to be feared that the closure

towards the peritoneum will be incomplete and consequently some of the paraffin might sink down into the abdominal cavity, *although this is of no evil consequence whatsoever.*

Moskiewitz[71] tried the mèthod in adults. He injected a walnut-sized umbilical hernia in a nine-year-old boy, and two of twice this size in a woman of forty-three and in a man of forty-seven, respectively. (Diameter of hernial opening not given.) After 10:20 ccm. of paraffin have been injected, the patient is told to stand up and press hard and the injection is continued, until even the strongest bearing down effort is unable to produce the hernia.



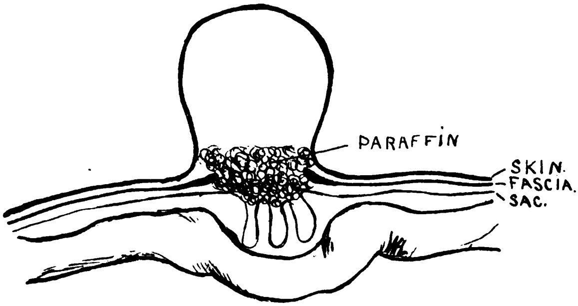
Diagramatic section of umbilical hernia.
non adherent reducible sac.

Figure 20.

As the literature of this country does not contain the report of a single case of injection of paraffin for umbilical hernia, we shall dwell upon the technics of the procedure in detail. It will be seen that our method differs materially from that advised and performed by Escherich, inasmuch as we at all times deposit our paraffin extraperitoneally. Escherich apparently pays no attention as to whether the hernial sac is reducible or not; he injects his paraffin into the space that remains after reducing the hernia, meaning to make his deposits intraperitoneally. Now there is no question in our mind, in view of our own experience, that Escherich also reduces

some of the non-adherent hernial sacs entirely and makes an extraperitoneal deposit.

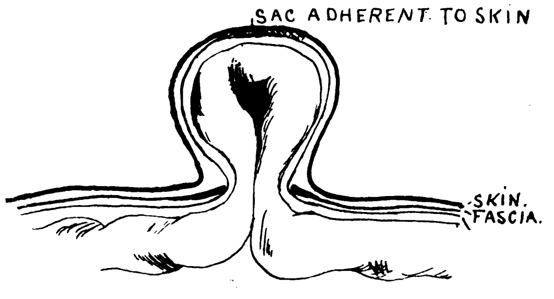
The field of operation, we repeat, is prepared with the same strict precautions as though an open operation were



Sac reduced. Paraffin injected, holding folded Sac within abdominal ring.

Figure 21.

contemplated. The technic of the operation depends to a great extent upon the size of the hernia, but notably on the presence or absence of adhesions between hernial sac and skin covering, in other words, upon the reducibility

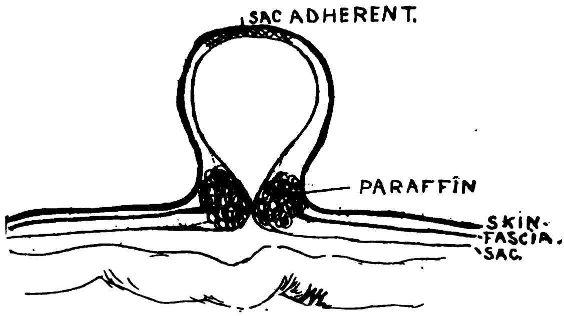


Section of Umbilical Hernia. Reducible Hernia but an adherent irreducible sac.

Figure 22.

or irreducibility of the hernial sac. If the sac is reducible (see figure 20) it is replaced within the abdomen,

the skin pinched up, the point of the needle inserted and the paraffin injected partly in the space remaining above the hernial sac and partly in the subcutaneous tissue around the ring. (Figure 21.) If, on the other hand, the sac is irreducible on account of being closely adherent to the skin (figure 22), the contents are reduced, the point of the needle inserted between the skin and the peritoneal sac in the subcutaneous tissue and, by manipulation of the needle, a circular deposit is made around the ring, sufficient to accomplish occlusion. (Figure 23.) In either case the freezing spray of ethyl chlorid is applied before the withdrawal of the needle. After the needle is removed, the puncture is sealed with collodion and the abdomen strapped with a band of adhesive plaster



Sac irreducible. Paraffin injected between sac and skin around ring, occluding sac.

Figure 23.

two inches wide. This is removed about one week after the operation, at which time the hernia is found to be effectively withheld by the paraffin prosthesis.

We have made use of this procedure in fourteen cases of umbilical hernia of both varieties without a failure, and without mishap of any kind whatsoever, although in some of the cases we know that we did puncture the intestines or omentum and also deposited paraffin within

the free abdominal cavity. This was caused by a sudden outburst of crying on the part of the child, and consequent filling of the hernial sac, and it could not be obviated, as we always operated without anesthesia.

CASE NO. 3.—Eva F., 4 years old (Mount Sinai Dispensary record No. 3772—1902). Congenital umbilical hernia. Otherwise healthy child, but a great cry-baby. Came to the clinic April 1, 1902, and was treated by strapping, with and without button, for a period covering almost two years, without the least benefit arising therefrom. It was not until after a most violent excoriation of the skin of the abdomen had been produced by the long-continued strapping that we determined to inject paraffin. By that time the hernia, which had not increased in size, certainly had not improved in the least. It was about one inch in diameter and projected about 1¼ inches beyond the surface of the abdomen. The ring was one-half inch in diameter. The hernial sac was large and flabby; being closely united to the skin it was with great difficulty reduced and with still greater difficulty kept reduced. This accounts, in large measure, for the failure of the strapping method—which in our experience should not be depended upon after the third year for congenital hernias of the umbilicus. *Operation,* January 15, 1904: Paraffin of a melting point of 115° F. injected into space left after reduction of hernial sac. Amount used, one dram. January 22d. Strapping removed; hernia reduced and does not protrude even while patient is made to cry. Paraffin pad felt around the ring as a hard lump. March 20th: Same condition; hernia reduced; paraffin lump in place.

CASE NO. 15.—Yetta S., 1½ years old (Mount Sinai Dispensary Record No. 2052—1905). Came to the clinic March 14, 1905: Congenital umbilical hernia, treated since birth by strapping with and without button. Diameter of ring, three-quarters of one inch, protrusion, 1¼ inches beyond abdominal surface. Hernial sac adherent to skin covering and irreducible. *Operation,* March 14, 1905: Paraffin of a melting point of 115° F. injected between skin and hernial sac around the ring. Retention immediate. Amount used, one dram. Band-

age applied. March 21st: Strapping removed; hernia reduced. Two months later: same condition continues.

The others of our cases of umbilical hernia cured by paraffin injections, drawn from private as well as clinic material come under the head of either of the two types reported above. They present no peculiarities and, therefore, will not be detailed here.

Umbilical and Ventral Hernia

(One Case)

Case No. 20.—Tilda K., 11 months old (Mount Sinai Dispensary Record No. 3802—1905). Referred to the clinic November 25, 1905, by Dr. Henry Heiman. Congenital umbilical hernia about three-quarters of an inch in size with a ring 1/4 inch in diameter. A second hernia is felt, and also distinctly seen about 1 1/2 inches above and to the right of the former, 1/2 inch in size, with a ring about 3/16 inch in diameter. Both easily reducible, the sacs being not adherent. After the usual operation for the umbilical opening, a second deposit of paraffin was laid down on top of the ventral hernia. Bandage. Eight days later complete closure of both rings.

Epigastric Hernia

(One Case)

Case No. 21.—Max K., 27 years old (Mount Sinai Dispensary Record 422—1906). Referred by Dr. A. A. Berg, who had previously performed at Mount Sinai Hospital an open operation for the same hernia. The patient had, however, developed a post-operative pneumonia, with persistent and violent coughing, which tore apart some of the sutures, thus destroying the operative result. *Diagnosis*: Epigastric hernia in the line of the scar, about the size of a walnut, reducible, showing a diastasis of 1/2 inch diameter. *Operation:* February 6, 1906. About 1 dram of paraffin (M. P. 120° F.) deposited over the ring. Strapped. When seen last, on March 15th, result excellent.

Inguinal Hernia

(*One Case*)

For reasons identical with those given in the chapter on injections in cases of umbilical hernia, the paraffin treatment of inguinal hernia is still in its infancy. A few cases operated on by Eckstein and by Moskiewitz are about all that have been published; and it is rather astonishing that, in view of their excellent results, no new developments have been recorded. Our own experience in this particular field is very limited, including, as it does, but a single case.

Case No. 22.—Mrs. Rose D., 32 years old, housewife, came to the clinic at Mount Sinai Dispensary on September 20, 1905, complaining of much discomfort and inability to do her housework because of bilateral inguinal hernia. *History:* The tumor on the left side developed five years ago upon lifting a heavy trunk; that on the right side about two years ago. She has been wearing a double truss since then, but owing to poorly developed fat-structure was constantly troubled by excoriations and pressure soreness. Scorning the suggestion of a radical operation, which had previously been made to her, she readily consented to the proposed paraffin injection. *Examination:* Upon standing, the inguinal herniæ are present. The one on the right side, about 2 inches in diameter; that on the left side about 2½ inches in diameter, both protruding 2 inches beyond the surface. Both easily reduced. Rather small inguinal rings. In recumbent position, herniæ are not spontaneously reduced, but when manually reduced they are easily produced again by coughing or by gentle bearing down. *Operation,* September 20, 1905: The field was prepared as for open operation; shaving was omitted, however, for the introduction of the needle was to be done outside of the hair line. No anesthesia. The hernia on the left side, the larger of the two, having been reduced, the tip of the left index finger invaginating the skin from a point slightly below, was rested over the inguinal ring on the edge of the pubis and Gimbernat's ligament. The needle, inserted at a distance about two inches externally,

was passed inwards until its point could be felt beneath the tip of the index finger over the ring and a deposit of one and one-half drams of paraffin (M. P. 120° F.) was injected. Immediately thereafter coughing, ever so violent, and bearing down, ever so hard, failed to cause a descent of the hernia. Again, upon standing, the hernia could not be produced on the injected side. After submitting to these rather severe tests a compress and spica bandage were applied over the seat of operation and the patient was allowed to go to her home, which was some distance from the clinic. September 22d: Returned to clinic and informed us that she had made the trip home—necessitating crossing by ferry of the East River and traveling some distance by trolley—without discomfort or pain. On examination, slight tenderness on pressure; some local heat but no redness at the site of paraffin deposit, which can be distinctly felt; the hernia remains firmly reduced without the slightest impulse being felt upon coughing or downward pressure.*

B. COSMETIC IMPROVEMENTS

Depressed Scars

(Six Cases)

Heretofore depressed scars, if amenable to correction at all, belonged to the domain of plastic surgery. Unusual skill on the part of the operator, painstaking technic in handling flaps and in skin-grafting, the most rigid aseptic precautions, prolonged detention of the patient from work, the wearing of unsightly bandages, necessitating frequent changes, etc., etc., were only some of the conditions demanded lest the result might be an utter failure. At best, it was often a question whether the resulting operation cicatrices were not as unsightly as the original deformities. Since the use of paraffin injections a large number of these cases, grading in magnitude from the elevation of a smallpox pit (Gersuny) to the filling of large defects after resection of the jaw, and such de-

*This patient was soon after operated upon at Mount Sinai Hospital for double inguinal hernia. Apparently, therefore, the conditions relapsed early and our injection was a failure.

pressions of medium size as a mastoid cicatrix (Broeckart)—has been corrected with little inconvenience and uniformly good results.

CASE NO. 23.—*Defect of Right Cheek after Removal of Right Inferior Maxilla.*

Figure 24. Charles S.—Before Injection.

Charles S., 26 years old, fur dealer. *History:* Eight years ago right inferior maxilla was resected. Has used with little satisfaction numerous dental contrivances to correct deformity. *Examination:* Large hollow depres-

sion of right cheek, in the bottom of which is a cicatrix four inches long extending from the ear to the symphysis of the jaw. (Figure 24.) There is entire absence of the right inferior maxilla. *Operation,* April 10, 1905: Injection of three ounces of paraffin (M. P. 115° F.) in

Figure 25. Charles S.—After Injection.

one sitting, with the large glass syringe. (See figure 15.) Depression filled out satisfactorily. April 12th: Slight edema around lower jaw; some redness; no pain; no tenderness. April 15th: A slight sinking downwards of the mass is noticeable, due, however, not to a displacement or moving of the paraffin in the tissues, but

to the stretching of the supporting skin above the mass by the tugging weight of three ounces of paraffin. The cosmetic result, however, remained highly satisfactory (figure 25).

CASE NO. 24.—*Depressed Bone Scar of the Head of Left Humerus.*

Ed. Q., 53 years old, a laborer, came to the clinic February 21, 1903 (Mount Sinai Dispensary Record No. 4717—1903). *History:* Twenty-one months ago he suffered a fracture at left shoulder by a severe fall. Evidently it had been a compound fracture followed by osteomyelitis of the humerus, for which he was operated upon in one of the city hospitals. *Examination:* Bony ankylosis of left shoulder-joint. Upper portion of external surface of arm presented a very unsightly depression about three inches long, one and a quarter inches deep and one and a quarter inches wide. The skin was firmly adherent to the bone at the bottom of the depression throughout its extent. The bottom itself was filled with the same filthy waxy, cholesteatomatous material so frequently seen in mastoid cicatrices, and was the source of considerable irritation and annoyance to the patient, for which he sought relief. *Operation,* February 24, 1903: Under nitrous oxid anesthesia skin dissected off the bone at the bottom of cavity. Edges of skin flaps freshened. Bone cavity thoroughly dried by tamponade with iodoformized gauze until hemorrhage ceased, and filled with paraffin (M. P. 120° F.) poured directly from the beaker while in fluid state. After solidification skin was sutured, and dressing applied. March 3, 1903: Wound healed by primary union. Paraffin block fills out the normal surface contour. September 10, 1903: Same condition. Apparently no shifting nor diminution of the paraffin mass.

CASE NO. 27.—*Depressed Bone Scar on Forehead.*

Esther S., 22 years old, a servant (Mount Sinai Dispensary Record No. 2096—1905), was referred to us March 23, 1905, by Dr. D. D. Goldstein. *History:* She was accidentally struck in the head with a hatchet 7 years ago. Healing of the wound required several months,

during which time bone splinters were repeatedly removed. *Examination:* Broad cicatrix, three-quarters of an inch wide, involving loss of bone and extending from inner canthus of right eye directly upward for three inches, just beyond the hair line of the scalp. Skin freely movable, not adherent. *Operation,* March 25, 1905: Needle inserted just above eyebrows, passed up beneath the skin, and injection of paraffin (M. P. 120° F.) made from above downwards as the needle was being withdrawn. Figure 26 shows reduced transverse topography of forehead at the level of the eyebrows, taken with a lead band. The dotted line represents the region after injection. March 27, 1905: Some swelling around site of injection and slight ecchymosis of the skin. April 5, 1905: Aspect normal. Swelling and discoloration have disappeared entirely. Result perfect.

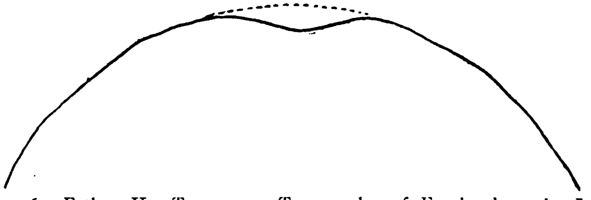


Figure 26. Esther H.—Transverse Topography of Forehead at the Level of Eyebrows. Heavy Line Before, and Dotted Line After, Injection.

The fourth case is a repetition of case three; the fifth was an injection for pitting of face after smallpox; the sixth, jagged, unsightly depressed scars of the neck following suppurative tuberculous adenitis. The result in all these cases was all that could be desired.

Hemiatrophia Facialis

(One Case)

Case No. 29.—Annie B., 23 years old (Mount Sinai Dispensary Record No. 390—1906), referred by Dr. Peterson. Congenital malformation amounting to a deficiency of the left lower jaw and apparent atrophy of the cheek, giving the same appearance as is produced by amputation of the maxilla. *Operation,* January 30, 1906: One ounce of paraffin (M. P. 115° F.) injected. This

amount proved not quite sufficient to fill out the defect in the cheek, although a great improvement was noticeable. A subsequent injection will be made. There was very little reaction after this injection of one ounce of paraffin, done without anesthesia, and with little, if any, pain, although in a highly sensitive and nervous patient.

Saddle-Nose

(*Thirty-five Cases*)

Paraffin injection for the correction of saddle-nose deformity is nowadays the routine method applied by rhinologists and general surgeons alike. A few illustrative cases are all we shall report here, reserving the full material for a later opportunity.

Roughly speaking, the cases of saddle-nose deformity can be divided into two general groups. There is a variety of cases, where the deformity is slight and limited to the soft parts only, leaving the nasal bones undisturbed. Congenital defects, superficial traumatism, loss of septum from lues, etc., are generally accountable for these deformities. The operation in these cases is, as a rule, a simple affair, requiring only the injection of the paraffin; and with the proper care not to overinject, the result is always good. This variety, however, constitutes the minority of the cases. The other group, embracing by far the greater number of the cases, shows considerable disfigurement, due either to the fracture, and subsequent healing with irregular displacement, of the divided nasal bones, or to loss of bone tissue from disease, as well as injury to the soft parts, with or without adhesion of the skin to the underlying bone. The operation in these cases may become a very complicated affair, possibly requiring an osteorhinoplasty, the refracturing and setting of the nasal bones, straightening of the nasal septum, elevation of the adherent skin by subcutaneous

dissection, etc., before the paraffin can be injected. A few illustrative cases of both groups follow.

. CASE No. 30.—*Traumatic Saddle-Nose Without Separation of Nasal Bones.*

Figure 27. Michael F.—Before Injection.

Michael F., 19 years old (Mount Sinai Dispensary Record No. 4676—1903). *History:* Fell from bicycle

four years ago. *Operation,* February 10, 1903: After the usual careful preparation, an injection of one dram was made (figures 27 and 28 show the patient before and after the operation). In spite of precautions taken to prevent the spreading of the paraffin, some of it escaped upwards and formed a slight tumor over the glabella, showing that our precautions were not strict enough. This is seen in figure 28. July 7, 1903: Lump over glabella excised. Shape of nose excellent.

Figure 28. Michael F.—After Injection.

CASE NO. 40.—*Traumatic Saddle-Nose.*

Moses L., 24 years old (Mount Sinai Dispensary Record No. 1026—1904). *Operation,* September 20, 1904:

Injection of one dram of paraffin (M. P. 120° F.). Figures 29 and 30 show the patient before and after operation.

Figure 29. Moses L.—Before Injection.

Figure 30. Moses L.—After Injection.

CASE NO. 60.—*Specific Saddle-Nose with Loss of Septum and Separation of Nasal Bones.*

G. D., 30 years old. *Operation*, February 14, 1905: One and one-quarter drams of paraffin injected. See figures 31 and 32.

Figure 31. G. D.—Before Injection.

Figure 32. G. D.—After Injection.

We want to remark here that any traumatism producing a thrombophlebitis may be the exciting cause of a gumma in a syphilitic. For that reason we have made it a routine practice to subject all luetic cases of nasal deformity to a thorough specific treatment before injection of the paraffin.

Figure 33. Katie F.—Before Injection.

CASE No. 37.—*Traumatic Saddle-Nose with Displacement of Fractured Nasal Bones.*

Katie F., 18 years old (Mount Sinai Dispensary Record No. 5119—1903), fell eight years previously and smashed her nose. *Examination:* Marked saddle-nose deformity. Nasal bones widely separated, overlapping

Figure 34. Katie F.—After Injection.

nasal processes of superior maxilla on either side. Sigmoid nasal septum. *Operation*, May 21, 1903: Under nitrous oxid narcosis both nasal bones refractured and set. Septum straightened. May 28, 1903: Injection of one dram of paraffin (M. P. 120° F.). See figures 33 and 34.

CASE NO. 38.—*Traumatic Saddle-Nose with Displacement of Fractured Nasal Bones.*

Nathan L., 27 years old. (Mount Sinai Dispensary Record No. 5248—1903). Sixteen months before nose was

Figure 35. Nathan L.—Before Injection.

injured by being hit with a baseball. *Examination:* Wide separation of fractured nasal bones at lower margin with flattening almost limited to the soft cartilaginous parts of the nose. Slight deflection of septum. *Operation,*

June 23, 1903: Nasal bones refractured and septum straightened under nitrous oxide anesthesia. June 27,

Figure 36. Nathan L.—After Injection.

1903: Injection of three-quarters of a dram of paraffin (M. P. 120° F.). See figures 35 and 36.

CASE NO. 58.—*Traumatic Saddle-Nose with Adherent Skin.* Alexander N., 42 years old.

Referred from Dr. J. Wolff's ophthalmological department at the dispensary. Several years ago nose was in-

Figure 37. Alexander N.—Before Injection.

jured, producing a most unusual deformity—compound fracture of both nasal bones and both nasal processes—and resulting in numerous cicatrices with adhesions of

the skin to the underlying bone. *Operation,* August 12, 1904: Under local anesthesia a subcutaneous dissection was made of the adherent cicatrices with a small teno-

Figure 38. Alexander N.—After Injection.

tome and one dram of paraffin (M. P. 120° F.) injected. See figures 37 and 38.

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